Santa Clara Valley Water District

2016

Infrastructure Reliability Plan

AECOM

6/30/2016

About the Santa Clara Valley Water District

The Santa Clara Valley Water District is the primary water resources agency for Santa Clara County, California. It acts not only as the county's water wholesaler, but also as its flood protection agency and is the steward for its streams and creeks, underground aquifers and District- built reservoirs.

As the county's water wholesaler, the District makes sure there is enough clean, safe water for homes, businesses and agriculture. As the agency responsible for local flood protection, the District works diligently to protect Santa Clara Valley residents and businesses from the devastating effects of flooding.

Our stream stewardship responsibilities include creek restoration and wildlife habitat project, pollution prevention efforts and a commitment to natural flood protection.

The mission of the District is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy.

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NOTICE: SOME APPENDICES TO THIS REPORT ARE CONFIDENTIAL AND ARE NOT PUBLIC DOCUMENTS

Executive Summary

The Santa Clara Valley Water District (District) undertook preparation of the 2016 Infrastructure Reliability Plan (IRP) in order to identify a combination of capital and operational improvements that would provide reliable water service to present and future, raw and treated water customers in Santa Clara County during a range of emergency events. The objective of the IRP was to ensure that the District's water supply infrastructure is reliable under a range of hazards.

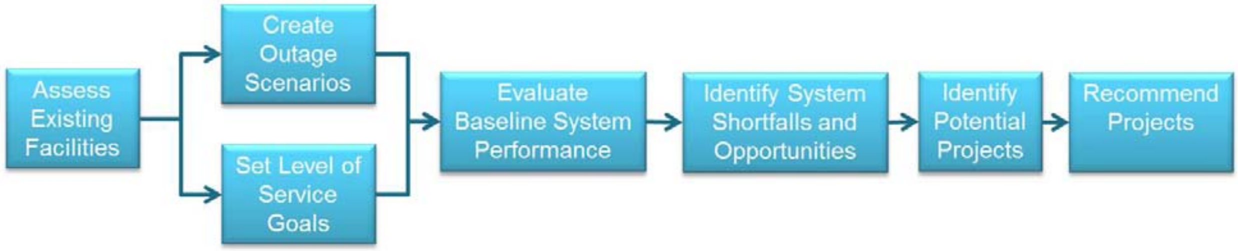
This report presents the findings of the IRP project with regard to existing system reliability and redundancy, potential outage scenarios, vulnerable facilities and regions, and recommended improvement projects. It summarizes a multi-year effort to review and evaluate the District's water supply system. The main body of the report summarizes major information and findings, while the appendices provide detailed supporting information. Eleven tasks, described in detail in **Chapter 1**, were executed and a technical memorandum (TM) was created to summarize the findings of each task.

This project is an update to the District's 2005 Water Infrastructure Reliability Project (2005 WIRP). The 2005 WIRP evaluated the performance of the District's system during a range of hazards, established a level of service (LOS) goal for District treated water following an emergency event, and identified potential improvement projects that would reduce system vulnerability. The purpose of this 2016 update is to:

- Review outage scenarios and update the reliability LOS goal
- Evaluate more regional, less capital intensive alternatives to the well fields proposed in the previous 2005 WIRP
- Identify projects that provide multiple benefits for added reliability, increased capacity and operational flexibility, and new treated or groundwater service connections

The general methodology that was used to identify system shortfalls and project opportunities is shown in **Figure ES-1**. Ultimately, the IRP identified projects to improve the reliability of the District system and enhance life safety for District customers. The recommended projects represent the culmination of a process that balanced capital planning methodologies, qualitative engineering judgement, quantitative analyses, customer recommendations, and stakeholder input.

Figure ES-1. Overview of 2016 IRP Process


Assess Existing Facilities
Create Outage Scenarios
Set Level of Service Goals
Evaluate Baseline System Performance
Identify System Shortfalls and Opportunities
Identify Potential Projects
Recommend Projects

Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be affordable. **There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level, while providing sufficient system reliability and performance.** The final recommended project portfolios meet the objectives of the IRP in a cost-effective manner, support new LOS goals identified during the project, and support other water supply interests, such as groundwater management and operational flexibility.

System Overview

The District's water supply system is comprised of storage, conveyance, recharge, treatment, and distribution facilities that include local reservoirs, groundwater sub-basins, out-of-county groundwater banking, groundwater recharge facilities, treatment plants, imported supply, and raw and treated water conveyance facilities (see **Figure 1** in **Chapter 1**). Maintaining public health and safety and ensuring the reliable operation of critical facilities following natural catastrophes and other system risks are fundamental objectives of the District. The IRP is an essential component to assessing and decreasing these risks.

The District delivers treated water to seven retail customers (retailers), and manages groundwater within the subbasin for three groundwater-only retailers. The ten retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and distribution systems. Following is the list of District retail customers:

- California Water Service Company (Cal Water)
- City of Gilroy (Gilroy)
- Great Oaks Water Company (Great Oaks)
- City of Milpitas (Milpitas)
- City of Morgan Hill (Morgan Hill)
- City of Mountain View (Mountain View)
- City of San Jose (San Jose Muni)
- San Jose Water Company (SJWC)
- City of Santa Clara (Santa Clara)
- City of Sunnyvale (Sunnyvale)

Although they do not receive District treated water or regularly use groundwater, the City of Palo Alto, Stanford University, and Purissima Hills Water District are located within the District's service area and were also included in the study.

Outage Scenarios

The goal of the IRP was to develop scenarios that captured a range of District planning objectives, and provide a reasonable “stress test” by which to measure District system performance and project improvements, and set performance goals. Outage scenarios were intended to reflect relevant hazards to the District for the purposes of measuring system performance with respect to water supply and delivery.

The selected outage scenarios were used in subsequent modeling tasks of the IRP to identify specific facility outage scenarios and to determine the impacts on potable water service. **The final selected outage scenarios include:**

- **Earthquake scenarios (two for San Andreas earthquake[1], one for Calaveras earthquake)**
- **Extreme Storm event**
- **Delta outages (6-month short-term outage, 24-month long-term outage)**
- **Regional power outage**

LOS and System Performance

For the purposes of the IRP, LOS objectives represented performance standards or targets for which the District’s system may strive to reach under various outage scenarios. ***This project considered one minimum winter month demand (February) as representing basic service and the base demand target for treated water delivery after a major disaster event.*** A range of preliminary LOS objectives (water delivery targets and restoration times) were considered for potential District system performance targets under various outage scenarios. An increase in the level of performance corresponded to increases in level of investments.

Modeling and analyses were used to quantify District system capabilities and to determine the restoration time for recovery with its current baseline system and planned capital improvements in place. The analysis determined how long it would take to restore retailer demands partially (winter demands) or in full (average demands) to the East and West treated water systems, and to restore critical managed recharge operations in the three earthquake scenarios and the extreme storm scenario. Additionally, a pipe damage analysis was conducted to identify the vulnerable sections of District transmission pipeline to target for improvements. A risk exposure assessment was also carried out in order to identify the District facilities that are most susceptible to failure.

For the Earthquake and Extreme Storm outage scenarios, the results of modeling and analyses demonstrated that, in the worst case scenario, the expected outage time before the District can provide minimum treated water demands to retailers is approximately 30 days. For less severe events, the expected outage time before minimum demands can be restored is only approximately 4 days. The recovery times for the District to provide average treated water demands to retailers are considerably longer, ranging from approximately 14 days to approximately 75 days.

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[1] *One San Andreas earthquake scenario with damages primarily on the West treated water system, one San Andreas earthquake with damages primarily on the East treated water system.*

For both the short-term (6-month) and long-term (24-month) Delta outage scenarios, the results of modeling and analyses demonstrated that the District can continue limited service (with an assumed 20% reduction in demand) for the outage durations with no imported water supplies. For the regional power outage, it was determined that the District can operate facilities on backup fuel storage for an estimated 3 to 10 days, depending on the time of year and operating conditions. The District could operate on backup power for longer periods given regular external fuel deliveries.

The project analyzed the availability of backup supplies for each retailer and looked for regional redundancies. Retailer service areas that can access other supplies to replace District treated water during a service interruption were identified. ***This effort found that many retailer service areas that are primarily served by District treated water have one or more backup supplies available, such as groundwater wells, interties, and San Francisco Public Utilities Commission (SFPUC) water supply.***

Specific critical areas that may have more difficulty withstanding potential outage durations include:

- **California Water Service Company – Vallco turnout area**
- **City of Milpitas – Milpitas turnout area**
- **City of Morgan Hill – all areas**
- **City of Mountain View – Zone 3 (Miramonte) area**
- **City of San Jose – Evergreen service area**
- **City of Santa Clara – Zone 2A (Serra Tank) area**

This effort found that improvement projects that target specific service areas may efficiently address the existing reliability issues.

Building Portfolios and Recommendations

The strengths and deficiencies in system performance under each outage scenario were used to develop strategies for reliable water supply and delivery after a disaster event. Improvement projects that help address the District's system reliability needs were identified and a project evaluation methodology was developed to refine a large list of potential improvement projects and opportunities into three final recommended project portfolios:

- Operations Only
- $10 Million Capital Improvement Program (CIP)
- $100 Million CIP

Three levels of screening were conducted to determine which projects efficiently provide the greatest benefits to system reliability while also being cost-effective and feasible. The analyses included two stages of cost estimates (generic and project-specific), which aided in the portfolio refinement process. **Chapter 5** presents the results of project analyses, culminating in final recommended project portfolios.

Potential opportunities were identified and discussed throughout the project, and via meetings, workshops, and specific information gathering efforts. ***Important concepts that have been incorporated in the identification of project opportunities and are reflected in the analysis methodology are listed below.***

Table ES-1. Project Analysis Guiding Concepts

Concept	Description
Incorporate recent operational knowledge	Recent events impacting District services, such as planned and unplanned maintenance outages of District pipelines and treatment plants, and drought conditions, have led to more knowledge regarding alternate operational schemes.
Account for backup supply redundancy	Many retailer service areas have sufficient backup supply redundancy and may not require large investments in additional reliability.
Address specific vulnerable areas	There are specific retailer service areas that are more vulnerable to outages of District treated water. Reliability in these specific areas may be effectively improved with lower cost, localized solutions, rather than major infrastructure improvements.
Consider raw water and treated water system interdependencies	Strengthening the District's treated water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant raw water system damage. Likewise, the inverse applies as well, as strengthening the District's raw water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant treated water system damage.
Leverage existing investments	Where possible and beneficial, leveraging existing assets is preferred, as the District, retailers, and SFPUC have made significant investments in increasing system reliability and operational flexibility since the last 2005 WIRP study.
Favor frequently used assets	Assets, particularly groundwater wells, which can be utilized more frequently to enhance daily operations or periodic maintenance operations, are preferred over assets that would be designated as standby for infrequent use only during major emergencies.

The final recommended projects are listed in **Table ES-2**. The projects are designated as District, retailer, or joint projects depending on which agency would lead the implementation. Projects on District facilities would be implemented by the District, while projects located within retailer service areas would generally be implemented by the respective retailers. In some cases, the project can be considered a joint project, meaning that the District and retailer would share the responsibility of implementation. Joint projects benefit both retailer and District systems and provide additional operational flexibility.

Table ES-2. Recommended Projects

Portfolio	Project #	Project Name/Description
Operations Only	🟦 1	Water Wheeling Study – Interagency use of District pipelines between customer turnouts
	🟩 2	Retailer Intertie Study – Test capabilities and capacities of interagency interties
	🟧 3	Lift operational restrictions on San Jose Muni Evergreen groundwater wells
	🟧 4	Disinfection for San Jose Muni Evergreen groundwater wells
	🟧 5	Equipment to utilize existing interties between San Jose Muni Evergreen and SJWC
	🟧 6	Upgrade intertie between San Jose Muni Evergreen and Edenvale service areas
$10M CIP	🟩 7	New Great Oaks service connection on Snell Pipeline to feed excess groundwater
	🟩 8	New groundwater well near Santa Clara Serra Tank in Zone 2A
	🟩 9	New groundwater well at Mountain View Miramonte Tank in Zone 3
	🟧 10	New groundwater well(s) at existing Milpitas site(s)
	🟧 11	New groundwater well(s) at Cal Water Vallco turnout area
	🟧 12	New groundwater well(s) at Existing Cal Water sites in western service area
	🟧 13	New groundwater well(s) in Evergreen at new San Jose Muni sites
	🟧 14	New groundwater well(s) near East Pipeline at new San Jose Muni sites
	🟧 15	Develop additional and upgrade existing interties for Cal Water
	🟧 16	New intertie between San Jose Muni Evergreen and Great Oaks
	🟧 17	Upgrade two existing interties between Great Oaks and SJWC
	🟦 18	Install two new isolation valves on Milpitas Pipeline
	🟦 19	Install three new isolation valves on West Pipeline
$100M CIP	🟦 20	Replace critical and vulnerable sections (~25,000 LF) of Almaden Valley Pipeline

🟦	**District Project**
🟩	**Joint Project**
🟧	**Retailer Project**

Additional recommendations were identified throughout the project to improve District resilience and recovery capabilities. These are not specific projects, and can be included in existing programs:

- Continue to plan recharge operations in critical areas during drought or other outages. In particular, upcoming improvements to Main and Madrone pipelines will support quicker restoration of critical recharge to the raw water turnouts in Morgan Hill.
- Continue emergency response planning
- Continue pipeline inspection and rehabilitation projects
- Address seismic and climate vulnerabilities through long-term asset replacements
- Consider practice of isolation valves immediately upstream/downstream service connections
- Continue coordination with District groundwater subcommittee to ensure appropriate practices
- Develop communications plans for water conservation messaging after hazard events

Conclusion

The District water utility system faces a variety of hazard conditions, which could lead to outages of treated water service and critical recharge. This study evaluated District system performance in several selected outage scenarios. Based on results of the analyses, the District currently meets a LOS for providing treated water at minimum demands within approximately 30 days or less, and critical recharge within approximately 75 days or less[1]. Utilizing information gathered via stakeholder meetings and workshops, this study also evaluated system capabilities with respect to regional redundancies and backup supplies. The study found that most areas of the county have sufficient backup supplies or redundancy to withstand a District service outage; however, specific service area vulnerabilities were identified. These can be more efficiently addressed by smaller localized projects, rather than major system infrastructure improvements. Project opportunities to enhance reliability for these service areas and the system overall were developed and screened. Stakeholders agreed on an investment level with corresponding recommended projects that would allow retailers to better tolerate these District service outages. These projects, shown above in **Table ES-2**, may also reduce the District service outage durations, thus improving the District's LOS. This study endorses implementation of these recommendations in the interest of enhancing District and retailer system reliabilities and life safety for their customers.

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[1] *Note these are modeled outage durations based on modeling assumptions. In actual hazard events, outages may be longer or shorter depending on actual facility damage.*

Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 1
Introduction

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1 INTRODUCTION

The Santa Clara Valley Water District (District) undertook preparation of the 2016 Infrastructure Reliability Plan (IRP) in order to identify a combination of capital and operational improvements that would provide reliable water service to present and future, raw and treated water customers in Santa Clara County during a range of emergency events. These improvements would meet the objectives of the IRP in a cost-effective manner, support new LOS goals identified during the project, and support other water supply interests, such as groundwater management and operational flexibility.

1.1. Summary

The objective of the District's 2016 IRP was to ensure that the District's water supply infrastructure is reliable under a variety of outage scenarios (emergency or hazard events). The project used hazard categories to identify specific facility outage scenarios, and to test and evaluate performance of the District system during an outage scenario. Ultimately, the IRP identified projects with the goal of improving the reliability of the District system and enhancing life safety for District customers. The recommended projects represent the culmination of a process that balanced capital planning methodologies, qualitative engineering judgement, quantitative analyses, customer recommendations, and stakeholder input.

The goal of the project was to examine and improve District water supply and service in the interest of system reliability and life safety.

This report summarizes a multi-year effort to review and evaluate the District's water supply system. The main body of the report summarizes major information and findings, while the appendices provide detailed supporting information. Throughout the report, blue text boxes reference where additional information can be found in the Appendices, and magenta text boxes are used to emphasize key information. Eleven tasks, described in detail later in this chapter, were executed and a technical memorandum (TM) was created to summarize the findings of each task.

1.2. 2005 Water Infrastructure Reliability Project

This project is an update to the District's 2005 Water Infrastructure Reliability Project (2005 WIRP). The 2005 WIRP evaluated the performance of District facilities during a range of hazard events. It found that the worst case scenario for the District's system is a magnitude

2005 WIRP LOS Goal

District potable water service at an average winter flow rate to at least one turnout per retailer in 7-14 days following a hazard event.

7.9 San Andreas earthquake in which the system could suffer up to a 60 day outage. The 2005 WIRP established a LOS goal for District potable water service following a hazard event and identified potential improvement projects that would reduce the vulnerability of the District system.

Task 3 TM includes:

- A summary of the recommended Baseline Portfolio, and Portfolios 1 and 2 from the 2005 WIRP
- The portfolio projects that have been completed by the District since the 2005 WIRP, as well as projects that are currently in progress or have been cancelled

The potential improvement projects were combined into groups of projects called "portfolios" that provided different LOSs at different costs. The project identified six different portfolios that included operational and capital improvements to meet the LOS goal (**Table 1**). The portfolios were designed to be cumulative, with a baseline portfolio and six additional portfolios that could be implemented sequentially. The Baseline Portfolio only included operational changes and reduced the outage time from 60 to 30 days. Portfolio 1 implemented programmatic elements and smaller system fixes in order to ensure life safety and allow the District to respond and communicate more efficiently after a hazard event. It would not further reduce the outage time from 30 days. Portfolio 2 increased the reliability of the system and adds an additional groundwater source, which reduces the outage time to 7 to 14 days. The Task 3 TM summarizes the portfolios from the 2005 WIRP.

Table 1. 2005 WIRP Portfolio Results

Portfolio	Purpose	Cost[3] (rounded)	Average Outage Period[4]	Controlling Event Outage Period[4]
Current System	Maintain status-quo	-	30-45 days	45-60 days
Baseline Portfolio	Stockpiling pipe and materials and emergency planning	$8 M	14 days	30 days
Portfolio 1	Life safety, programmatic elements, small fixes	$32 M	14 days	30 days
Portfolio 2	Adding one reliable source of groundwater	$150 M	1 day	7-14 days
Portfolio 3	Adding ability to use water from Lexington Reservoir	$352 M	1 day	7-14 days
Portfolio 4	Adding ability to use water from Anderson Reservoir throughout the system	$443 M	1 day	7 days
Portfolio 5	Increasing reliability of State and Federal sources	$669 M	1 day	1-3 days
Portfolio 6	Adding ability to loop treated water to link the east and west sides of the system	$1.8 B	1 day	1-2 days

[1] Portfolio 6 was not modeled, since complete recovery was achieved in other portfolios and the portfolios are cumulative in nature. Minimum achievable outage period for Portfolio 6 is kept at 1-2 days for controlling San Andreas event due to system capacity limits and inability to meet increased demands from pipe breaks in retailer systems and fire following earthquakes.

[2] One turnout on each side of system for San Jose Water Company.

[3] Costs include operations and maintenance and inflation costs.

[4] Time to restore supply to at least one turnout per retailer at average winter demand. "Average Outage Period" refers to the Southern Hayward or Central Calaveras Earthquake Event. "Controlling Event Outage Period" refers to the San Andreas Earthquake Event.

The Portfolios were evaluated based on LOS (outage period), analysis of benefit-costs, appraisal of key indicators, and assessment of rate impact. **The 2005 WIRP team recommended Portfolio 2, which also included projects identified in the Baseline Portfolio and Portfolio 1, and consisted of a total of seventeen projects grouped into seven project categories. This portfolio met the preliminary LOS goal of potable water service to at least one turnout per retailer within seven days and was projected to cost $150 million.**

Portfolio 2 Project Categories

- Stockpiled Materials (pipes)
- Life Safety
- Emergency Planning and Studies
- Agreements
- Capital Improvements
    - Groundwater Wells
    - Line Valves
- Operational Improvements
- SCADA

Most, but not all of the projects that were recommended from the 2005 WIRP have been implemented, which has reduced outage time to 30 days. One recommendation was stockpiling large diameter spare pipe and improving emergency response planning so the District is ready to repair a pipe quickly if it fails. The District implemented this recommendation in 2008 at a cost of $2.4 Million, and maintains a stockpile of large diameter spare pipe at Coyote and Vasona pump stations. The District also maintains a stockpile of internal pipeline joint seals, valves, and pipeline appurtenances. The stockpile marks a significant increase in reliability of the District's water supply system, as it helps to reduce outage time following a large earthquake from approximately 60 to 30 days.

The District also completed several emergency planning recommendations in 2014 at a cost of $150,000, to help meet the goal of reducing outage time to 30 days. These include developing a list of contractors available on standing order to use during an emergency event, improving the Water Utility Departmental Emergency Operations Center (DOC), and participating in CalWARN, a mutual aid network for water and wastewater utilities. Additional projects that were recommended in the 2005 WIRP and have been or are being implemented are listed below.

- Stabilize the SCADA system at Rinconada Water Treatment Plant (Completed in 2007 at a cost of $25,000)
- Improve the Post-Earthquake Dam Inspection Program (Ongoing, approximately $35,000 per year)
- Conduct a comprehensive SCADA study/SCADA system master plan (Completed in 2011 at a cost of $465,000)
- Seismic retrofit of the operations buildings at Rinconada, Penitencia, and Vasona Pump Station (capital project in construction, to be completed in 2017 at a cost of $21.2 Million)
- Construct a back-up raw water control center (capital project in planning, to be completed in 2025 at a cost of $6.9 Million. Note the Capital project name is SCADA Remote Architecture and Communications Upgrade)
- Install four line valves on the District's treated water pipelines to allow the District to isolate damaged portions of pipelines (Safe clean water project A3, scheduled to begin in 2025 at a cost of $13.9 Million)

The emergency well fields project in Portfolio 2 that helped reduce the outage time to 14 days were not implemented due to:

- **Reduced funding:** Board reduced funding to $20M in Fiscal Year (FY) 2012 Capital Improvement Projects (CIP) to accommodate other higher priority projects (Anderson Seismic Retrofit, Rinconada Water Treatment Plant (RWTP) Reliability Improvements).
- **District reliability improvements:** Dam seismic retrofits, pipeline air release valve upgrades, and RWTP upgrades
- **Retailer reliability improvements:** Increased storage capacity, interties with other retailers, and investments in increased reliability of San Francisco Public Utilities Commission (SFPUC) supplies
- New knowledge:
    - ***Operating with system outages:*** Some retailers have experience operating without District treated water supplies for short durations during District planned and unplanned pipeline shutdowns.
    - ***Post-disaster service levels and capabilities:*** Other recent National disasters have provided more insight regarding water use and needs following major hazard events.

The purpose of the 2016 update was to:

- **Review outage scenarios and update the reliability level of service goal**
- **Evaluate more regional, less capital intensive alternatives to the recommended well field option**
- **Identify projects that provide multiple benefits for added reliability, increased capacity and operational flexibility, and new treated or groundwater service connections.**

1.3. District System Background

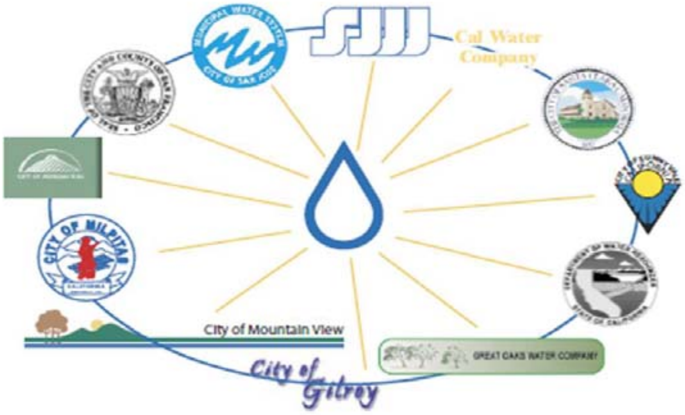
The District system includes imported water sources, ten raw water reservoirs (total storage capacity 169,000 acre-feet), 114 miles of raw and treated water pipelines, three potable water treatment plants, one recycled water treatment plant, and one District pump station (**Figure 1** on following page). In addition, there are two pump stations and 28 miles of raw water pipelines owned by the United States Bureau of Reclamation (USBR) but operated and maintained by the District, as well as a District/SFPUC intertie. More information on the District's system can be found in **Chapter 2**.

The District delivers treated water to seven retail customers (retailers), and manages groundwater within the subbasin for three groundwater-only retailers. The ten retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and distribution systems. Following is the list of District retail customers (also shown in **Figure 2**):

- California Water Service Company (Cal Water)
- City of Gilroy (Gilroy)
- Great Oaks Water Company (Great Oaks)
- City of Milpitas (Milpitas)
- City of Morgan Hill (Morgan Hill)
- City of Mountain View (Mountain View)
- City of San Jose (San Jose Muni)
- San Jose Water Company (SJWC)
- City of Santa Clara (Santa Clara)
- City of Sunnyvale (Sunnyvale)

Although they do not receive District treated water or regularly use groundwater, the City of Palo Alto, Stanford University, and Purissima Hills Water District are located within the District's service area and were also included in the study.

Figure 2. Retailer Customers and Imported Water Suppliers



The retail customers receive District treated water under the terms set forth in individual delivery agreements. Many of these agencies also extract groundwater from the groundwater basins managed by the District. More information on the retailers can be found in **Chapter 2**.

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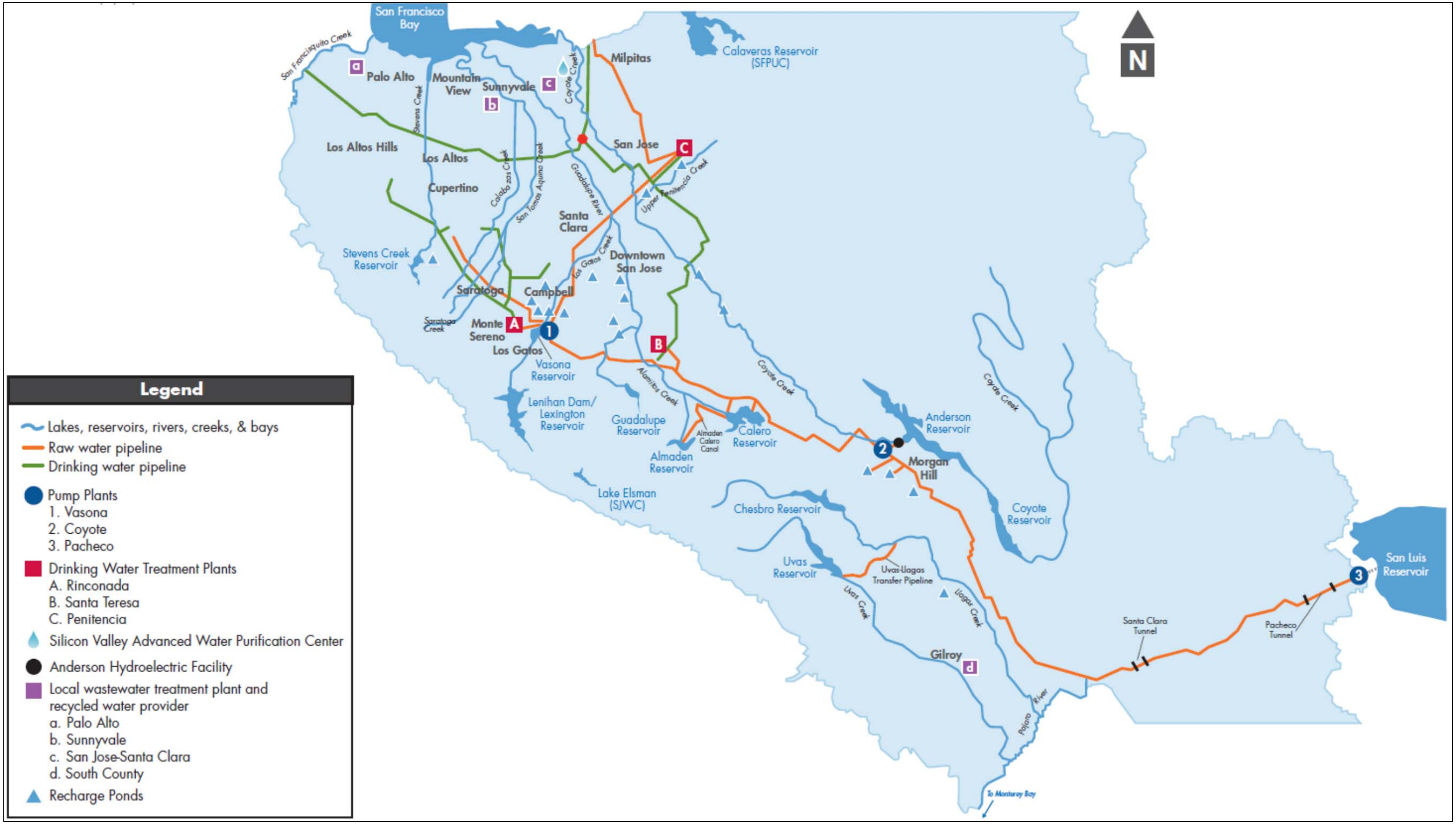
Figure 1. Overview of District's Water Supply System in Santa Clara County



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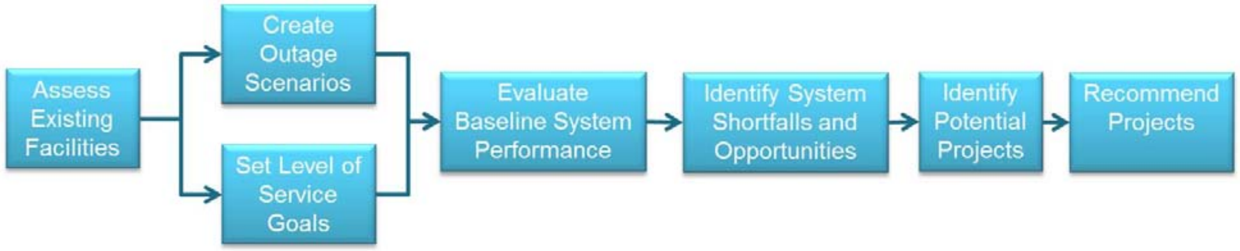
1.4. Project Methodology

The 2016 IRP quantified District system capabilities, needs and deficiencies, and potential improvement projects in order to develop LOS objectives and facilitate identification of desired District system performance. A high level assessment was performed to determine potential impacts on District facilities from different types of hazards that the region could face. Evaluation of the reliability of water supplies and facilities on a regional basis (District system, retail customer systems, and imported supply systems) was paramount to developing the most cost-effective combination of improvements or new facilities required to meet the District's system reliability goals. Strategies and projects to improve system reliability were then identified and developed. The 2016 IRP methodology is summarized in **Figure 3**.

Figure 3. Overview of 2016 IRP Process


Assess Existing Facilities
Create Outage Scenarios
Set Level of Service Goals
Evaluate Baseline System Performance
Identify System Shortfalls and Opportunities
Identify Potential Projects
Recommend Projects

Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be cost-efficient. There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level (i.e., $10 Million range), while providing sufficient system reliability and performance. The LOS objectives for the 2016 IRP represent performance standards or targets for which the District's system may strive to reach under various potential hazards.

2016 LOS

There was a consensus among retailers that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level ($10 Million range), while providing sufficient system reliability and performance.

The process followed the following Tasks to guide the project team in assessing the needs of the system and identifying solutions:

Task 1: Project Management
- Manage the scope of work

Task 2: Meetings
- Gather stakeholder input throughout the project

Task 3: Describe Infrastructure System
- Describe the District's and the Retailers' infrastructure systems

Task 4: Potable Water Use
- Describe District Retailers' potable water use

Task 5: Develop Outage Scenarios

- Develop hazard scenarios that represent the outages for which the District needs to plan
- Summarize the expected infrastructure damage and outage durations for different hazard types

Task 6: LOS Goals

- Set LOS goals for a range of system outages

Task 7: Potable Water Service Modeling

- Summarize modeling results and quantify impacts of outage scenarios on potable water service

Task 8: Regional Redundancy

- Analyze regional redundancies and capabilities

Task 9: Reliability Improvement Needs

- Summary of reliability improvement needs to address LOS shortfalls

Task 10: Other Improvement Needs

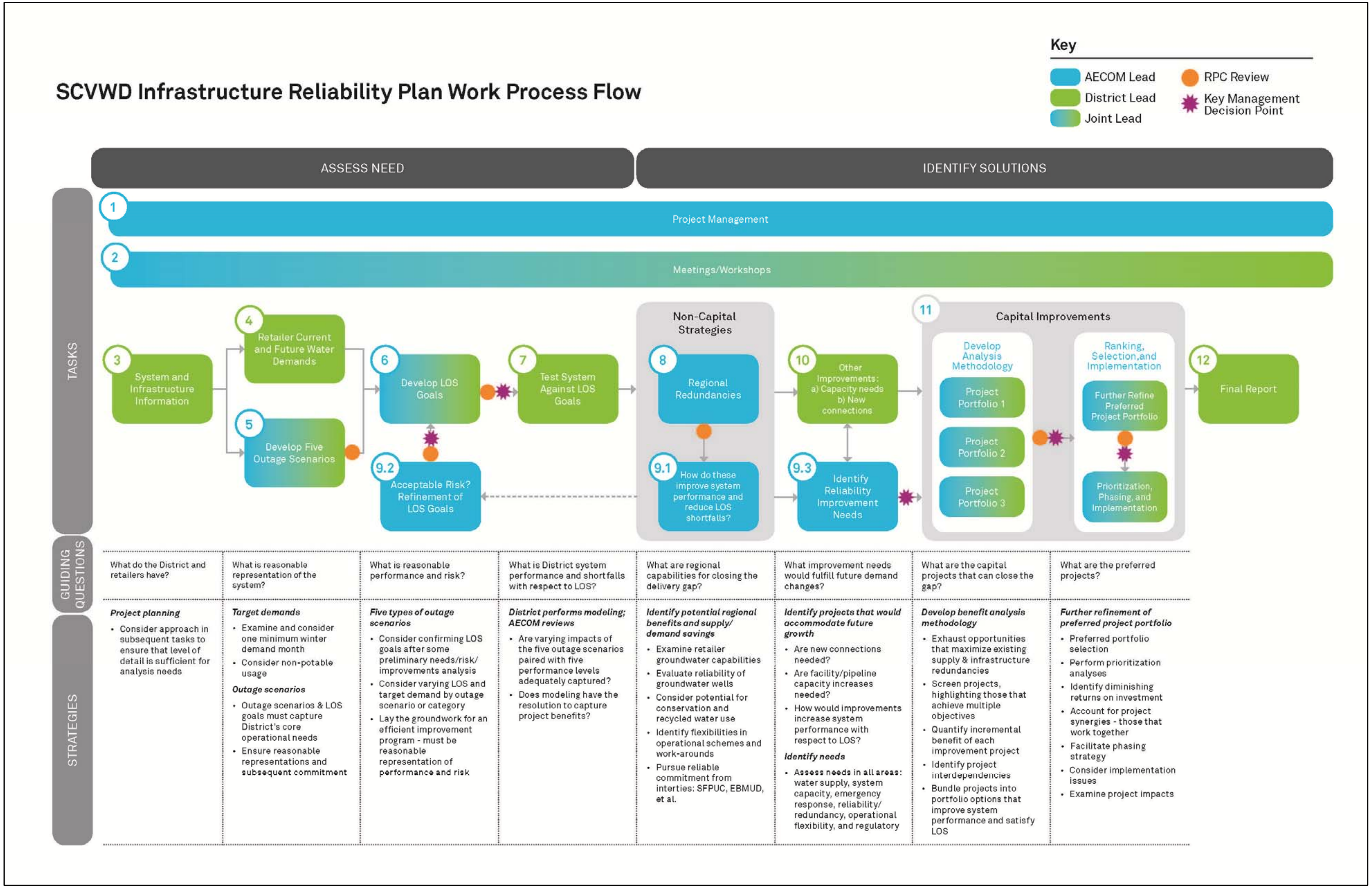
- Summary of other improvement needs to address LOS shortfalls

Task 11: Identify Projects

- Analyze and identify improvement projects to meet identified reliability needs

A flow diagram in **Figure 4** shows an iterative process that refined the LOS goals after system improvement needs had been identified.

Figure 4. SCWVD Infrastructure Reliability Plan Work Process Flow Diagram


SCVWD Infrastructure Reliability Plan Work Process Flow
Key
AECOM Lead
District Lead
Joint Lead
RPC Review
Key Management Decision Point
ASSESS NEED
IDENTIFY SOLUTIONS
TASKS
1 Project Management
2 Meetings/Workshops
3 System and Infrastructure Information
4 Retailer Current and Future Water Demands
5 Develop Five Outage Scenarios
6 Develop LOS Goals
7 Test System Against LOS Goals
9.2 Acceptable Risk? Refinement of LOS Goals
Non-Capital Strategies
8 Regional Redundancies
9.1 How do these improve system performance and reduce LOS shortfalls?
10 Other Improvements: a) Capacity needs b) New connections
9.3 Identify Reliability Improvement Needs
11 Capital Improvements
Develop Analysis Methodology
Project Portfolio 1
Project Portfolio 2
Project Portfolio 3
Ranking, Selection,and Implementation
Further Refine Preferred Project Portfolio
Prioritization, Phasing, and Implementation
12 Final Report
GUIDING QUESTIONS
STRATEGIES

What do the District and retailers have?	What is reasonable representation of the system?	What is reasonable performance and risk?	What is District system performance and shortfalls with respect to LOS?	What are regional capabilities for closing the delivery gap?	What improvement needs would fulfill future demand changes?	What are the capital projects that can close the gap?	What are the preferred projects?
Project planning • Consider approach in subsequent tasks to ensure that level of detail is sufficient for analysis needs	***Target demands*** • Examine and consider one minimum winter demand month • Consider non-potable usage ***Outage scenarios*** • Outage scenarios & LOS goals must capture District's core operational needs • Ensure reasonable representations and subsequent commitment	***Five types of outage scenarios*** • Consider confirming LOS goals after some preliminary needs/risk/ improvements analysis • Consider varying LOS and target demand by outage scenario or category • Lay the groundwork for an efficient improvement program - must be reasonable representation of performance and risk	***District performs modeling; AECOM reviews*** • Are varying impacts of the five outage scenarios paired with five performance levels adequately captured? • Does modeling have the resolution to capture project benefits?	***Identify potential regional benefits and supply/ demand savings*** • Examine retailer groundwater capabilities • Evaluate reliability of groundwater wells • Consider potential for conservation and recycled water use • Identify flexibilities in operational schemes and work-arounds • Pursue reliable commitment from interties: SFPUC, EBMUD, et al.	***Identify projects that would accommodate future growth*** • Are new connections needed? • Are facility/pipeline capacity increases needed? • How would improvements increase system performance with respect to LOS? ***Identify needs*** • Assess needs in all areas: water supply, system capacity, emergency response, reliability/ redundancy, operational flexibility, and regulatory	***Develop benefit analysis methodology*** • Exhaust opportunities that maximize existing supply & infrastructure redundancies • Screen projects, highlighting those that achieve multiple objectives • Quantify incremental benefit of each improvement project • Identify project interdependencies • Bundle projects into portfolio options that improve system performance and satisfy LOS	***Further refinement of preferred project portfolio*** • Preferred portfolio selection • Perform prioritization analyses • Identify diminishing returns on investment • Account for project synergies - those that work together • Facilitate phasing strategy • Consider implementation issues • Examine project impacts

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The work flow process allowed the project team and District to build on the knowledge gained from each task and assess the needs of the District. Task 3 efforts included gathering information on the District's system and led to an understanding of retailer systems and infrastructure as well. The average, minimum, and maximum monthly demands presented in Task 4 were used to understand desired demand and supply conditions, and to determine which retailer systems may have excess usable capacity compared to current use. Task 5 identified potential vulnerabilities and outages and developed representative scenarios based on the types of outage events for which the District needs to plan and prepare. The LOS goals developed in Task 6 addressed each of the outage scenarios selected in Task 5. The modeling efforts in Task 7 were used to determine how outage scenarios impact the District's ability to deliver potable water supplies to the retailers.

The remaining tasks allowed the District to identify solutions based on system needs. Task 8 identified the zones within each retailer service area that may be at lower risk of service outage if the District's system fails, due to the availability of excess capacity, back-up supplies, or availability of regional support. The existing system performance shortfalls were linked to specific outages and LOS goals in Task 9, and to conceptual system and/or operational needs. Information on future growth was used in Task 10 to determine if future water treatment or distribution capacity needs could be addressed by infrastructure reliability improvements. Task 11 then determined how the District can most efficiently and cost-effectively address the needs for improving system performance with respect to selected outage scenarios.

The work process flow included multiple review meetings throughout the project in order to gather input and receive feedback from retailers, internal technical staff, and District management. The project team met individually with each retailer to review and confirm the information developed throughout the project. Potential opportunities were identified and discussed via meetings, workshops, and specific information gathering efforts. These meetings are discussed further below and summarized in **Table 2**.

Table 2. Summary of Retailer Meetings

Purpose of Project Meetings	Date
▪ Explain project background ▪ Review system and infrastructure ▪ Discuss future water use ▪ Identify information needs	March 2014 one-on-one meetings
▪ Review selected outage scenarios	October 2014 workshop
▪ Develop LOS goals	December 2014 one-on-one meetings
▪ Provide updates on outage scenarios and modeling ▪ Gather input on potential opportunities and solutions	August 2015 one-on-one meetings
▪ Review initial project list	November 2015 workshop
▪ Discuss project recommendations	June 2016 workshop

A variety of relevant retailer information was gathered during the course of this project and via additional discussions at retailer meetings and workshops. This information can be found in the Retailer Information Appendix. The information has led to an understanding of retailer infrastructure (Task 3), water demands and future usage (Task 4), potential vulnerabilities and outages (Task 5), needed and desired LOS (Task 6), and resulting outage impacts (Task 7). For the purposes of Task 8 and subsequent tasks, this information required a consolidated format to facilitate confirmation by stakeholders and further study for accomplishing project goals. A database has been developed which can generate a collection of retailer information sheets into a report.

In addition, retailer system maps have been developed showing retailer service area boundaries, geographic relation to District pipelines, locations of turnouts, and additional turnout information. These maps were useful to understand retailer service areas and facilitate discussions that helped clarify information.

Retailer Appendix includes:

- Retailer Database
- Updated Retailer Reports
- Retailer LOS Meeting Notes (Task 6 TM)
- Retailer Service Area Maps
- Groundwater Supply Overview Maps
- IRP Retailer Supply Source and Service Area Maps

1.5. Report Organization

The main objective of this report is to incorporate and document all of the information developed under the project and include recommendations for facility and operational improvements. The main body of this report provides a high level summary of the work that was performed, documents the results of the analyses, and highlights the recommended reliability improvements and implementation plan. It includes references to the detailed reports and technical memoranda which are available in the appendices. The technical reports provide more detailed discussions of specific topics including the geologic evaluation, LOS goals, retail customer coordination, baseline system reliability evaluation, portfolio development, evaluation criteria, and cost estimate assumptions. The six chapters included in the main body of this report are:

Chapter 1 – Introduction provides a background of the development of this project, lists the objectives for the report, and describes the report organization.

Chapter 2 – District System Background describes the District's water supply system, including critical facilities, and provides assumptions used for the basis of the IRP, hazard identification, LOS goals, and system hydraulics and operations.

Chapter 3 – Outage Scenarios discusses the development of the scenarios which represent the types of outages the District needs to prepare for, and identifies the expected infrastructure or facility failures in each hazard event.

Chapter 4 – Baseline System Evaluation discusses the results of the reliability evaluation of the existing District system for each retailer, and identifies existing capabilities and system performance shortfalls.

Chapter 5 – Portfolio Recommendations describes the development of project portfolios (capital and operational projects), revised LOS goals, and recommends an overall system improvement portfolio and implementation plan.

Appendices are organized by subject matter in order to simplify access to more detailed project materials. ***NOTE: SOME APPENDICES ARE CONFIDENTIAL.***

- **Project Task Support Appendix** includes all of the TMs that were developed for each task of the project
- **Infrastructure System Appendix** describes all the District's water supply system and includes District specific maps and descriptions of infrastructure
- **Climate Change Outage Appendix** includes the project work related to climate change and extreme weather evaluations
- **Maintenance Outage Appendix** contains the Maintenance Outage TM
- **Delta Levee Outage Appendix** includes all of the research and analysis of the impacts of a Delta Levee Failure including vulnerability and the status of regional repairs and upgrades
- **Earthquake Outage Appendix** describes the earthquake risks and vulnerabilities of District pipelines
- **Power Outage Appendix** contains the Fuel Analysis TM that was prepared to evaluate the impact of a regional power outage on baseline system performance
- **Retailer Information Appendix** contains retailer specific information and detailed maps and reports

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Santa Clara Valley
Water District

Infrastructure Reliability Plan

Chapter 2
System Background and Use

AECOM

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2 SYSTEM BACKGROUND

The mission of the District is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy.

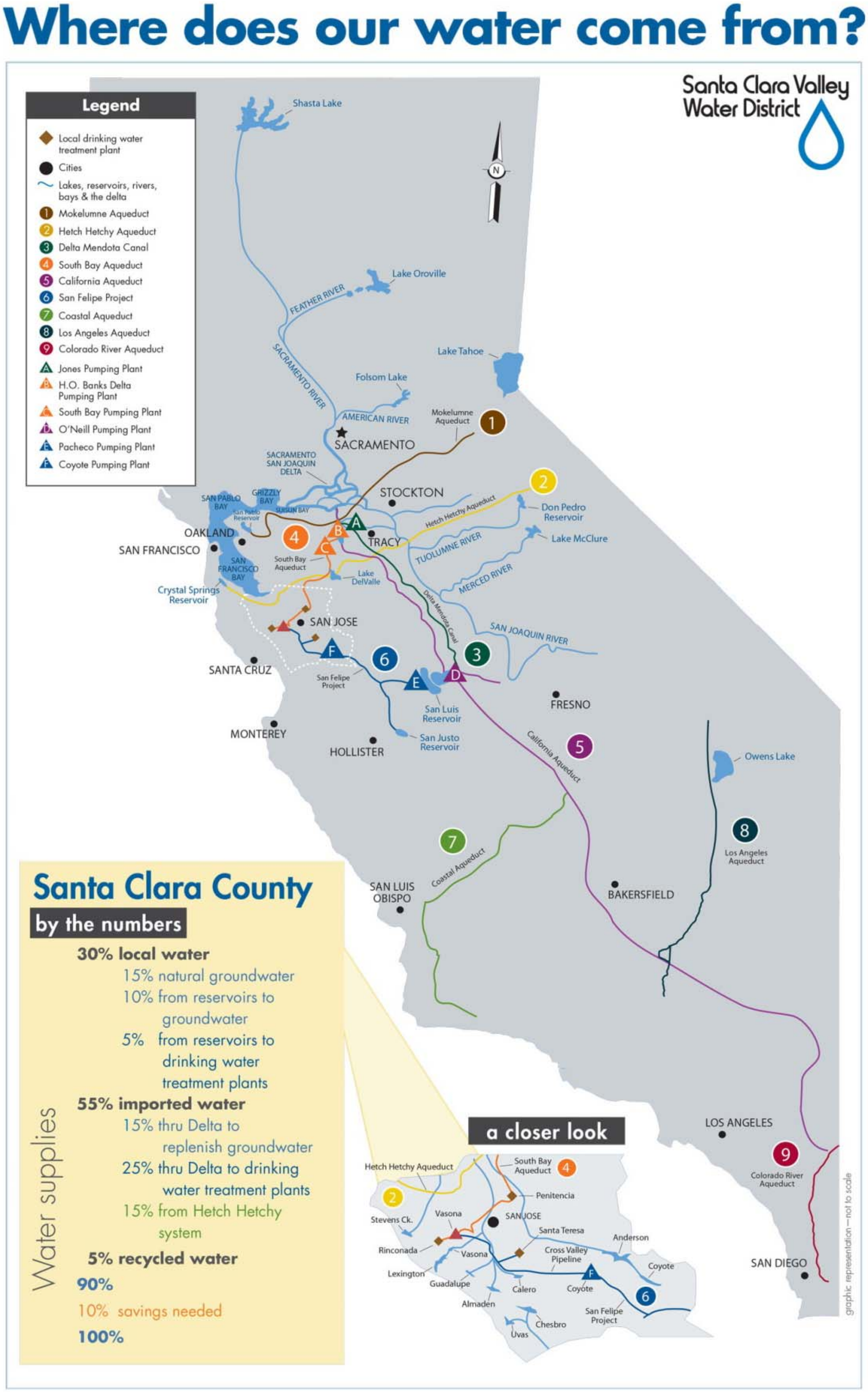
The District's water supply system is comprised of storage, conveyance, recharge, treatment, and distribution facilities that include local reservoirs, groundwater sub-basins, out-of-county groundwater banking, groundwater recharge facilities, treatment plants, imported supply, and raw, treated, and recycled water conveyance facilities. Maintaining public health and safety and ensuring the reliable operation of critical facilities following natural catastrophes and other system risks are fundamental objectives of the District. The IRP is an essential component to assessing and decreasing these risks.

This chapter describes the District's water supply system, including critical facilities, and provides assumptions used for the basis of the IRP, hazard identification, level of service goals, and system hydraulics and operations.

2.1. Santa Clara County Water Supply Sources

In addition to providing treated water in Santa Clara County, the District also manages the groundwater basin. In order to meet the county's water needs while maintaining maximum efficiency and flexibility, the District utilizes a comprehensive water supply management strategy and a variety of water supply sources. Santa Clara County's diverse water supplies include locally developed and managed water, water imported from the Sacramento-San Joaquin Delta (Delta), and recycled water, as shown in **Figure 5**. The District's comprehensive water supply management activities include the managed recharge of imported and local supplies, in-lieu groundwater recharge through the provision of treated surface water and acquisition of supplemental water supplies, and programs to protect, manage and sustain water resources. The activites augment local supplies and help to reliably meet the needs of county residents, businesses, agriculture, and the environment.

Figure 5. District Water Supply Sources



2.1.1. Local Supplies

The District collects local supplies, including rainfall and surface water runoff, in reservoirs such as Anderson and Calero, which as shown in **Figure 6**, are connected to the raw water distribution system and can supply the District's water treatment plants. Local groundwater resources make up the foundation of the county's water supply. The District also has numerous water rights to divert and store local surface water from creeks and streams. Captured local surface water is used to replenish the groundwater sub-basins through an actively managed recharge program and provides supply for the District's drinking water treatment plants.

2.1.2. Imported Supplies

In a normal year, imported water supplies account for slightly more than half of the annual supply delivered within Santa Clara County. The District imports water from the Sacramento-San Joaquin Delta (Delta) through the State Water Project (SWP) via the South Bay Aqueduct (SBA), and from the Central Valley Project (CVP) through the San Luis Reservoir (**Figure 6**). CVP and SBA imported water is sent to the District's three water treatment plants, recharge ponds or creeks, or to local reservoirs for later release to supplement groundwater recharge. Imported water is also brought into the county through the SFPUC system.

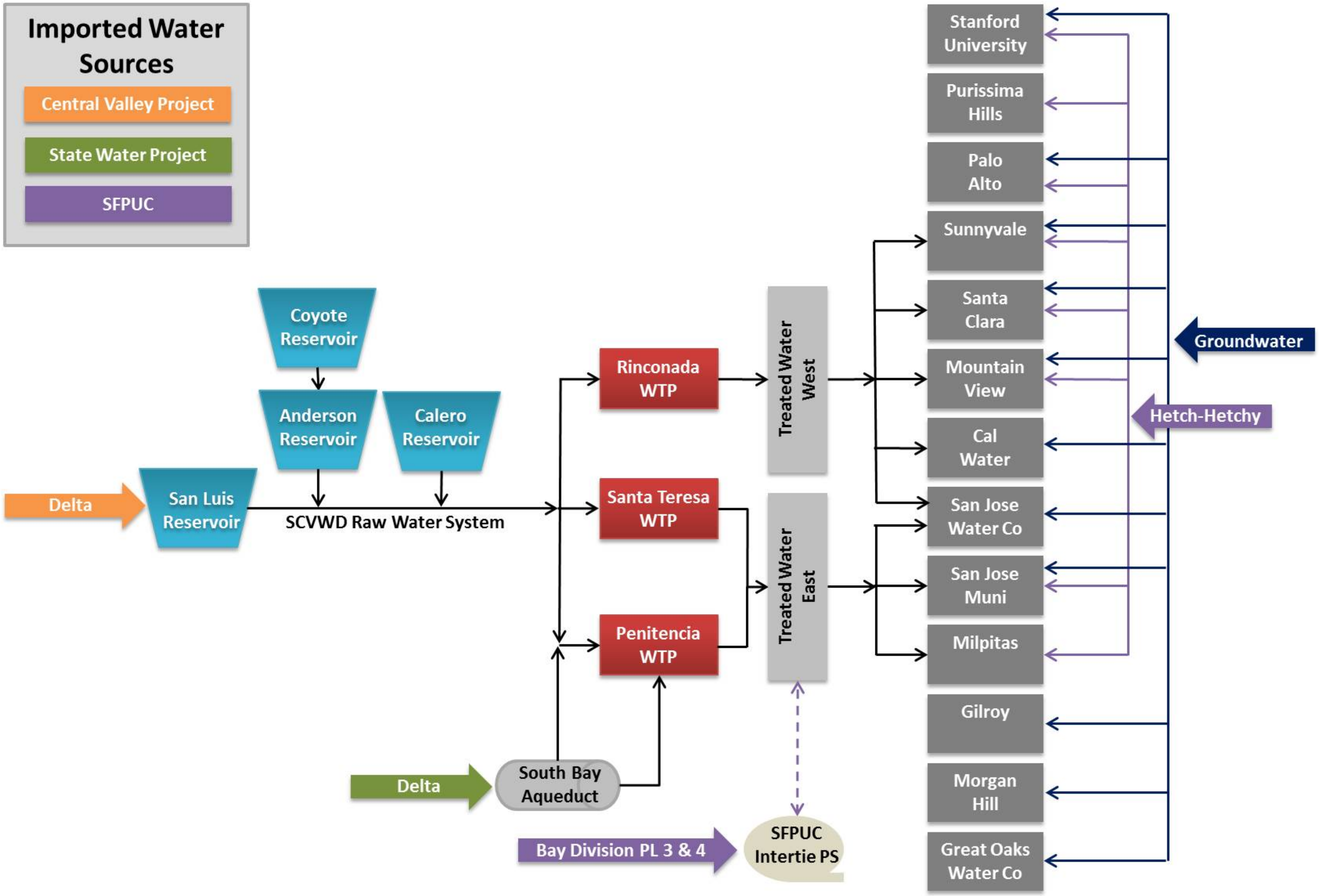
2.1.3. Recycled Water

A small, but important and growing source of water is recycled water, which is used for non-potable uses including irrigation, industry, and agriculture. Using recycled water helps conserve drinking water supplies, provides a drought-proof and locally-controlled water supply, and reduces dependency on potable supplies. Recycled water was not specifically analyzed as part of this project since current uses are non-potable. However, it is an important water supply source that will increase the resiliency of the District's system, especially if it is accepted for direct or indirect potable uses in the future. Some considerations for the Silicon Valley Advanced Water Purification Center (SVAWPC) have been documented as part of the Climate Change efforts in the Climate Change Outage Appendix.

2.1.4. Desalination

Desalination as a water supply solution was not specifically evaluated as part of this project. The high cost of implementation made it infeasible as a project alternative and was thus not considered.

Figure 6. Water Supply Sources and Treated Water Supply System Overview



2.2. District Water Supply System

Imported water from the SWP comes from the Delta through the SBA in the northern portion of Santa Clara County. The SWP water is typically treated at Penitencia Water Treatment Plant, or sent through the Central Pipeline to Rinconada Water Treatment Plant for treatment, or to managed recharge facilities.

Imported water from the CVP comes through the San Felipe Division facilities, consisting of San Luis Reservoir, Pacheco Pump Station, Pacheco Tunnel, Pacheco Conduit, Santa Clara Tunnel, Santa Clara Conduit, and Coyote Pump Station. From there, water is typically sent to Santa Teresa or Rinconada Water Treatment Plants for treatment via the Cross Valley, Calero, and Almaden Valley Pipelines, and to various managed recharge facilities throughout the county.

Four of the District's local reservoirs are connected to the transmission system and can supply the District's water treatment plants. Most notably, Anderson Reservoir feeds the Cross Valley Pipeline, and Calero Reservoir feeds the Almaden Valley Pipeline. Water from each of these reservoirs would typically be treated at Santa Teresa or Rinconada Water Treatment Plants.

The District's managed recharge facilities are used to replenish the groundwater basin so that groundwater levels are maintained, supplies are available for retailer pumping, and subsidence is avoided. The managed recharge systems allow the District to maintain groundwater levels in the groundwater basins.

A diagram of the facilities in the District's water supply system is shown in **Figure 7**. System overview maps and a more detailed system schematic map that includes retailer turnouts are available in the Infrastructure System Appendix.

Infrastructure System Appendix includes:

- System Overview Maps
- Detailed System Schematic Maps

Figure 7. Diagram of District Water Supply System

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2.2.1. District System Capacity Constraints

Information on future growth was used in Task 10 to determine if additional water treatment or distribution capacity is needed in the future in the District's system. The District's 2012 Water Supply and Infrastructure Master Plan (WSIMP) analyzed the water treatment plants and pipelines to identify constraints for existing infrastructure under future 2035 demands.

The 2012 WSIMP made recommendations with regards to future capacity constraints, but did not recommend any major infrastructure projects to address future capacity. Instead, it recommended monitoring and preparing for increased pumping in the future. The Task 10 TM includes a discussion of how the WSIMP capacity recommendations relate to the IRP.

Task 10 TM includes:

- Capacity failures due to future demand increases or changes
- Recommended improvements for capacity
- Summary of constraints for each system
- Discussion of future LOS goals

2.3. Retailer Water Supply Systems

Seven retailers receive treated water from the District's treated water system, while three retailers receive only groundwater. The District's treated water distribution system is physically separated into two separate systems, one that serves the east and one that serves the west side of Santa Clara County. The east side of the District's treated water system serves the following retailers:

- Milpitas
- San Jose Muni
- San Jose Water Company (SJWC)

The west side of the District's treated water system serves the following retailers:

- Cal Water
- Mountain View
- Santa Clara
- Sunnyvale
- San Jose Water Company (SJWC)

Retailer Appendix includes:

- Retailer Reporting Database Sheets
- Updated Retailer TMs
- Retailer Service Area Maps

Eight local water retailers in the northern portions of the county receive imported water directly from the SFPUC system. Additionally, Stanford University and the San Jose Water Company hold surface water rights, and some retailers utilize recycled water for non-potable uses.

Information on the physical capabilities and limitations of retailer supply sources was gathered and evaluated in the Retailer Reports that were developed in Task 3 and also further quantified in Task 8. Additional retailer meetings were utilized to further understand and confirm the physical capabilities and limitations of retailer supply sources. The maximum infrastructure transmission limitations of each water supply source for each District retailer include groundwater yield, turnout capacity, and contractual limits, not necessarily reflecting available source. **Table 3** presents these results and lists the maximum capacity of each water supply source for each District retailer.

Table 3. Maximum Capacity of Retailer Water Supply (MGD)[1,2]

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Capacity
Cal Water	13.0	6.0	n/a	n/a	19.0
Gilroy	18.8	n/a	n/a	n/a	18.8
Great Oaks	31.0	n/a	n/a	n/a	31.0
Milpitas[2]	1.7	14.4	36.0	n/a	52.1
Morgan Hill	15.3	n/a	n/a	n/a	15.3
Mountain View[2]	6.4	2.5	11.4	n/a	20.3
San Jose Muni[2]	19.6	30.0	21.6	n/a	71.2
San Jose Water Company[2]	100.0	182.0	n/a	25.0	307.0
Santa Clara[2]	54.0	5.8	10.8	n/a	70.6
Sunnyvale[2]	9.0	18.6	53.4	n/a	81.0
TOTAL	268.8	259.3	133.2	25.0	686.3

[1] This is not necessarily the amount of supply available, as capacities may be restricted by physical infrastructure limitations.

[2] MGD = millions of gallons per day

[3] Also has capacity to utilize recycled water supplies which were not included in the analysis.

Some of the retailers receive their water supply from multiple sources, while others, such as Gilroy, Great Oaks, and Morgan Hill rely solely on groundwater supplies. More information can be found in the Retailer Appendix.

2.4. Retailer Water Use

The potable water supplies used by the District's retailers were identified in the Task 4 TM. The project team gathered monthly demand data for each retailer and analyzed monthly demand by water supply source. The demands presented in the Task 4 TM were used for analysis in subsequent project tasks. For example, the average, minimum, and maximum month demands were reviewed and analyzed in setting level of service goals as part of Task 6. Retailer water demand graphs were compiled, which show the yearly and monthly demand trends and the percent of water use by supply source. The retailer demand graphs can be found in the Retailer Appendix.

Task 4 TM includes:

- Summary of planned future growth
- Summary of historical retailer demands (see the Retailer Appendix for retailer-specific demand graphs)
- Detailed demand tables and charts that include historical water usage and future growth adjustments
- Demand analysis methodology
- Future growth area map

2.4.1. Planned Future Supply Source Changes or Growth

Known future growth or supply source changes for the retailers were also identified in the Task 4 technical memorandum. The project team gathered information on future growth and supply source changes from retailer Urban Water Management Plans[1] (UWMPs), which identify the supplies water providers will use to meet future demand, and then met individually with each retailer to review and confirm the demand and growth information the team had gathered.

As confirmed through discussions with treated water retailers earlier in this project, very few new connections or areas of growth were identified. The following retailers had growth areas that were estimated and incorporated in demand calculations for the project:

- Milpitas
- San Jose Muni
- Santa Clara
- Gilroy

At this time, there are no specific recommendations for new infrastructure with regards to the identified areas of growth. All existing connections are assumed to be sufficient to address these areas.

Historical demands were compared to growth projections to determine if the water supply demand or source would be projected to change for future planning purposes. All retailers indicated that demand has either stayed the same or decreased over the past 10 years. Most retailers indicated that there are no plans to change or add supply sources in the future. In other words, they generally plan to continue utilizing the same distribution of supplies, thus utilizing relevant historical retailer demand data was appropriate.

2.4.2. Minimum Retailer Usage

The minimum retailer usage is represented by the winter demand (the average water usage for the month of February). Winter demands are a starting point for benchmarking the minimum service to provide the public in the aftermath of a major disaster. Winter demands generally do not include landscaping and other significant outdoor water use that are present during other seasons, and which may be considered extraneous during emergency situations. However, it is an amount based on historical data that can be reasonably associated with day-to-day continuity of residential and

Task 8 TM:

- Lists the maximum infrastructure transmission capacity of each water supply source for each District retailer
- Includes minimum retailer usage by source/supply utilizing historical retailer demand data

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[1] *The 2010 UWMPs were used for this report. The 2015 UWMPs were not available, but are currently in progress.*

business operations and needs. **Table 4** presents the minimum usage of each water supply source for each District retailer, developed as part of Tasks 4 and 8.

Table 4. Minimum Retailer Usage by Water Supply Source (MGD)

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Minimum Usage
Cal Water	2.0	5.2	n/a	n/a	7.2
Gilroy	4.7	n/a	n/a	n/a	4.7
Great Oaks	7.2	n/a	n/a	n/a	7.2
Milpitas	0.0	3.8	5.2	n/a	9.0
Morgan Hill	3.8	n/a	n/a	n/a	3.8
Mountain View	0.3	0.6	6.3	n/a	7.2
San Jose Muni	3.2	8.8	3.3	n/a	15.4
San Jose Water Company	27.5	46.6	n/a	10.5	84.7
Santa Clara	10.6	3.4	2.6	n/a	16.6
Sunnyvale	0.7	6.1	6.5	n/a	13.2
TOTAL	60.1	74.5	24.0	10.5	169.1

The total minimum usage (169 MGD) represents the minimum amount of water that all of the retailers have used from all sources from a historical perspective. The minimum demands were reviewed in subsequent tasks to determine if any retailer systems have excess usable capacity compared to current use. For example, a retailer may have 10 MGD of well capacity, but only uses 2 MGD typically. The excess capacity could be used in an emergency or outage scenario to meet demands.

2.5. District Infrastructure

The District's water supply system includes imported water sources, 10 dams, and raw water reservoirs (total storage capacity of 169,000 acre-feet), 152 miles of raw and treated water pipelines, three raw water pump stations, three potable water treatment plants, 400 acres of managed recharge ponds and associated systems, several in-stream diversion dams, one well field (three wells), a purified water treatment plant, and an intertie pump station with SFPUC. The physical characteristics, capacity, age, condition, and known risks or upgrades of the District's Infrastructure system were updated and documented in the District Facility Description Report included in the Infrastructure System Appendix.

The District's infrastructure summary tables that were prepared for the WSIMP were updated as part of Task 3. A summary of the District's water transmission system facilities are provided below in **Table 5.**

Task 3 TM:

- Updated the District's infrastructure summary tables that were prepared for the WSIMP

Table 5. Infrastructure Summary Table

Infrastructure	Quantity	Size/Capacity
District Service Area		1,300 sq. mi.
Imported Water Supplies	3	
SF Water Dept Bay Division[1]		77,000 ac-ft/yr (contract amt)
San Felipe Project[2]		152,500 ac-ft/yr (contract amt)
South Bay Aqueduct[3]		100,000 ac-ft/yr (contract amt)
Raw Water Pipelines	11	79.7 mi (20" to 120" diam)
Treated Water Pipelines	10	39.8 mi (20" to 84" diam)
Water Treatment Plants:	3	
Rinconada		80 MGD
Santa Teresa		100 MGD
Penitencia		40 MGD
Raw Water Pump Stations:	3	
Coyote		153,492 gpm; 12,000 hp
Pacheco		301,055 gpm; 24,000 hp
Vasona		72,000 gpm; 1,200 hp
Treated Water Pump Stations	3	
Dutard		4,000 gpm; 85 hp
Graystone		27,760 gpm; 400 hp
SFPUC Intertie		
Raw Water Reservoirs	10	169,000 ac-ft
Treated Water Reservoir	1	15 MG
Groundwater Recharge Facilities	20	393 ac
Raw Water Canals		17 mi
Tunnels	3	
Pacheco (raw water)		7.0 mi
Santa Clara (raw water)		1.4 mi
Santa Teresa (treated water)		0.34 mi
Hydroelectric Facilities	1	900 kW
Diversion Dams	9	25,000 ac-ft
Canals and Ditches	4	17.3 mi
Natural Recharge Channels		Approx. 90 mi

[1] *Owned & Operated by SFPUC*

[2] *Owned by US Bureau of Reclamation; Operated by the District*

[3] *Owned & Operated by California Department of Water Resources*

2.5.1. System Redundancy

The District's current raw water conveyance system contains a fair amount of redundancy, and has flexibility to allow changes in operations for providing service in the case of a single facility or pipeline failure. The raw water system pipelines and pump stations can convey any supply source (San Luis, Calero, or Anderson Reservoirs, or the SBA) to any water treatment plant (Rinconada, Santa Teresa, or Penitencia), with limitations on capacity in some operational scenarios.

The District's treated water system operates as two separate systems, the East and West Side systems. The East Side system can be supplied by three redundant treated water sources. The East Side System is connected to two District water treatment plants, Santa Teresa Water Treatment Plant and Penitencia Water Treatment Plant, and has a connection with the SFPUC for use in times of emergency. The District/SFPUC intertie has a pumping capacity of up to 40 MGD, and allows for the exchange of water between the two systems in the event of planned or unplanned system outages in either system. An interruption or outage of SFPUC or other imported supplies could have significant impacts on the county's water supply reliability.

The West Side is supplied by the Rinconada Water Treatment Plant, which is currently being upgraded to provide redundancy and reliability. The District's Campbell well field provides a limited amount of back-up treated supply, approximately 2MGD, to the West side system.

2.5.2. Critical Facilities

For the purpose of this study, "critical" is defined as any facility that is essential (that must remain functional) to supplying water and to meeting the level of service demands of the District customers. Specific infrastructure includes the District's supply, transmission, and treatment facilities, the groundwater basin, and imported water facilities.

Task 3 TM:

- Summary of District Infrastructure
- Evaluation of District Critical Facilities from the 2005 WIRP
  - Asset Management Program Ranking
  - Seasonal Variation in Criticality
  - 2005 WIRP Ranking

A list of critical facilities was developed for the 2005 WIRP to identify the specific District facilities that are critical to system functions of supplying and delivering potable water. The 2005 WIRP rankings were reviewed and evaluated along with facility rankings by the Asset Management Program (*Evaluation of District Critical Facilities from the 2005 WIRP report*).

The 2005 WIRP Critical Facility list was used to identify the current District facilities that are critical to system functions of supplying and delivering potable water. The final complete list of critical facilities is included in two matrices, one matrix for raw water system and one matrix for treated water system (Infrastructure System Appendix).

This critical facilities matrix summarizes the infrastructure necessary for system performance in supplying and delivering potable water to District customers. The list was utilized to quantify impacts of hazard events by identifying the critical facilities affected and potential facility outage severities and durations.

Infrastructure System Appendix includes:

- District Facility Descriptions
- Critical Facilities Matrix
  - Facility outage durations
  - Raw water facility matrix
  - Treated water facility matrix

2.5.3. Vulnerable Facilities

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2.5.4. Infrastructure Improvements

The District monitors condition of its facilities through its Asset Management Program. As conditions worsen, the District initiates projects to rehabilitate or replace infrastructure. Some facility conditions have degraded since the 2005 WIRP, making them more vulnerable to hazard events. The District has implemented or plans to implement other projects to improve system reliability. The District has also made significant progress in improving the reliability of its pipelines through its pipeline maintenance program, which upgrades pipeline appurtenances such as air release valves and in-line valves.

The District is in the process of, or is slated to begin some significant improvement projects. Note that this is not the complete list of projects in the District's current CIP.

- Seismic retrofit of key water supply reservoirs, including Anderson and Calero Dams
- Improvements to Rinconada Water Treatment Plant, a key facility for the west treated water system
- Improvements to the Main and Madrone pipelines, which will allow the District to deliver water from Anderson reservoir to the Main and Madrone ponds

Task 3 TM includes:

- Reliability improvements to the infrastructure system that were not part of the 2005 WIRP
- List of distribution system improvement projects that are included in the District's 5-year CIP

The District's planned improvement projects were considered in the evaluation of baseline performance of the system.

2.6. Retailer Infrastructure

Retailers own and operate their own water system facilities including reservoirs, treatment plants, wells, tanks, and pipeline systems. Current information on the retailers, their supplies, and systems is a critical element of the IRP update. Task 3 included updates to Retailer System Reports (which were last prepared in 2004 for the 2005 WIRP). The updates focused on infrastructure and include detailed information on infrastructure reliability improvements made since the previous study.

Updated Retailer System Reports (Retailer Appendix):

- Summary of retailer systems
- System maps and schematics
- System descriptions
- Recommendations from 2004 Reports
- System improvements since 2004 Reports

Table 6 summarizes the conclusions of each retailer report, as well as preliminary considerations for improving the reliability of retailer systems. Specifically, the recommendations address system deficiencies or considerations with regard to a reduction or loss of District treated water deliveries.

Table 6. Retailer Report Conclusions and Considerations

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Chapter 3
Outage Scenarios

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3 OUTAGE SCENARIOS

An objective of the IRP was to develop outage scenarios that provide a reasonable "stress test" by which to measure District system performance and project improvements, and set performance goals. Outage scenarios were intended to reflect relevant hazards to the District for the purposes of measuring system performance with respect to water supply and delivery. The strengths and deficiencies in system performance under these scenarios were used to develop strategies for reliable water supply and delivery after a disaster event.

This chapter discusses these outage scenarios and evaluates the impacts to District facilities from different hazards. This chapter also presents a range of preliminary LOS objectives for potential District system performance targets under the various hazard conditions. The outage scenarios were used in subsequent modeling tasks of the IRP to identify specific facility outages and determine the impacts on potable water service.

3.1. Hazard Categories

Multiple hazard categories were considered during the selection of outage scenarios in order to encompass the range of potential impacts relevant to the District. Specific hazard categories were selected and analyzed in the Task 5 TM. Based on conceptual assessments and subsequent discussions with District staff and stakeholders, the following major hazard categories were selected for further development and evaluation:

- Climate Change and Extreme Weather
- Earthquakes
- Delta Outage
- Regional Power Outage (evaluated in Task 7)
- Maintenance Outage
- SCADA Outage
- Water Quality Event

These major hazard categories encompass a large range of potential impacts. **Table 7** summarizes the high-level assessment that was considered to determine potential impacts of each hazard category on types of District facilities.

Task 5 TM:

- Documents the evaluations and analyses performed during the planning process
- Describes the selected outage scenarios that were identified
- Includes high-level assessment of the impacts of hazard categories on District facilities

Table 7. High-Level Assessment of Hazard Categories

Hazard Category	Long-term Supply Sources (State/Federal)	Short-term Supply Sources (District Storage)	Raw Water Transmission Facilities	Water Treatment Plants	Treated Water Transmission Facilities
Extreme Weather	X	X	X	X	X
Maintenance Outage		X	X	X	X
Earthquake	X	X	X	X	X
Delta Outage	X				
Regional Power Outage			X	X	
SCADA/Controls Failure			X	X	
Water Quality Event			X	X	

Based on this conceptual assessment and discussions with District staff, all of the hazard categories were selected for further consideration and evaluation except for a SCADA/Controls Failure and a Water Quality Event. SCADA outage impacts are generally captured by other outage scenarios, and the District has some operational capabilities for manual operations of the system if necessary in case of an event that disables SCADA controls. For water quality events, minor events typically have shorter durations of impact and may be mitigated by redundancy in the raw water system, while major water quality events, such as terrorist-related events, have a low probability of occurrence.

The remaining hazard categories – Climate Change and Extreme Weather, Earthquake, Delta Outage, Regional Power Outage, and Maintenance Outage – were analyzed in more detail. Following further evaluation of each hazard category, the Maintenance Outage category was eliminated as an outage scenario (see Section 3.1.5). The following sections summarize development of the selected broad hazard categories into specific outage scenarios, by identifying the specific District facilities impacted for each. These outage scenarios were utilized in evaluating system performance in subsequent tasks.

3.1.1. Climate Change and Extreme Weather

Climate Change Appendix:

- Evaluated how climate change and extreme weather may impact the District's water supply system infrastructure
- Includes climate change impact background and research
- Identifies infrastructure expected to be impacted
- Describes sensitivity of failed infrastructure
- Describes risk assessment methodology

Climate change and related extreme weather events that may result in infrastructure failure were identified in the *Infrastructure Reliability Climate Change and Extreme Weather Technical Memorandum* (Climate Change Appendix). Extreme weather in Santa Clara County includes severe storms, drought, and heat waves. These events have occurred historically and can occur at any time, but are generally not considered to be frequent or high probability events. Climate change is projected to increase the frequency and/or magnitude of the extreme weather events. The Climate Change TM considered the risk that extreme weather events pose on water utility infrastructure, regardless of whether it is an existing extreme weather event, or if it is a future event that may be exacerbated by climatic changes. The Climate Change TM evaluated how climate change and extreme weather may impact the District's water supply system infrastructure.

Multiple types of extreme weather events were evaluated in order to determine the specific type of event that poses the greatest risk to the District's water supply system infrastructure. The first step defined the impact on District assets due to each extreme weather event. After the impacts were identified, the next step was to assess vulnerabilities in order to identify and determine exposure routes or exposure points from the extreme weather event to District facilities. The risk assessment then looked at how published climate and extreme weather projections could impact the District's vulnerable water supply system infrastructure.

It was determined that the extreme precipitation event, which causes riverine flooding, has the highest risk of impact for the District. Thus, an extreme storm was selected as the most severe and representative climate change outage scenario.

3.1.2. Earthquakes

District facilities cross three major faults that may cause considerable interruptions to water supply and delivery. The 2005 WIRP identified three likely earthquake events:

- San Andreas M7.9 (San Andreas)
- Central Calaveras M6.2 (Calaveras)
- Southern Hayward M6.7 (Hayward)

Task 5 TM includes:

- Discussion of facility probabilities of failure in earthquake scenarios
- Earthquake outage scenario refinements and final selections

Multiple preliminary outage scenarios were developed for each earthquake event and documented in the Task 5 TM. It was determined that Hayward event vulnerabilities are generally captured by San Andreas event scenarios, and therefore a specific outage scenario was not needed for Hayward. Two San Andreas scenarios and one Calaveras scenario were selected to capture the risk to District facilities in the event of a major earthquake. The final selected earthquake scenarios incorporated additional discussions with the District team, previous study information, likely facility probabilities of failure and expected pipeline breaks and leaks, and high-level considerations for probable facility outage combinations. The three final selected earthquake outage scenarios were:

- San Andreas #1 (M7.9 on the San Andreas fault with damages primarily on the West Side)
- San Andreas #2 (M7.9 on the San Andreas fault with damages primarily on the East Side)
- Calaveras (M6.2 on the Central Calaveras fault)

Earthquake Appendix includes:

- Updated information on infrastructure impacts
- Drought and earthquake recurrence interval evaluation

3.1.3. Delta Levee Failure

The District imports 40 to 45% of its water supply for customers from the Sacramento-San Joaquin Delta (Delta) via the SWP and CVP pumping plants (*see schematic in the Delta Appendix*). The Delta is extremely susceptible to catastrophic damage in the event of earthquakes, floods, and other threats in and around the Delta region. Failure of the Delta system could potentially reduce or stop water deliveries from the Delta for weeks, months, or even years (SWP Delivery Reliability Report, 2013; BDCP, 2013). A summary of the State Delivery Report can be found in the Delta Appendix.

Existing studies and findings were leveraged in the Delta Levee Failure TM to assist with evaluating and quantifying potential Delta outages, particularly the Delta Risk Management Strategy (DRMS) project conducted by the California Department of Water Resources (DWR).

Based on findings from the evaluation, it appears the geographic distance makes it unlikely that significant damage in the Delta and facility outages in the District service area would occur simultaneously as a result of selected seismic and extreme flood events. To capture risks of a Delta failure event, unique outage scenarios to capture Delta-specific failures are appropriate. As a result, two Delta outage scenarios were identified:

- Short-term/6-month Delta outage
- Long-term/24-month Delta outage

Delta Appendix includes:

- Delta import schematic
- State Delivery Report Summary TM
- Delta Status Summary TM
- Emergency Freshwater Pathway TM
- Delta Levee Failure TM:
  - Background on Delta levee failures
  - Probabilities of flood and earthquake risk
  - Estimated time to repair levees and restore water exports

These outages were defined based on the current status of the Delta, which is summarized in the Delta Status Summary TM. Because the Delta is so important to water retailers and because it offers a multitude of other benefits to the State of California, it is likely that any necessary repairs to the Delta would be prioritized in an emergency. Numerous initiatives and programs have already been undertaken in order to protect and enhance the Delta's valuable assets and to manage the state's water resources. More information can be found in the Emergency Freshwater Pathway TM.

3.1.4. Regional Power Outage

As discussed in the Fuel Analysis Technical Memo (Joe Hill Consulting Engineers (JHCE) and AECOM), the District's capabilities with respect to a regional power outage were analyzed using two approaches:

1. The first analysis considered fuel requirements from a prolonged power outage with the assumption that all facilities are operable for the duration of the power outage and will require emergency fuel to operate. Based on historic outages in the United States, a two-week power outage was selected for the analysis.
2. The second analysis utilized the IRP outage scenarios and accounts for facility outages or lack of source water. The analysis incorporated the specific facility outage scenarios identified in this project and quantified fuel needs associated with the hazard events. In this analysis, it was assumed that fuel is only needed at a particular facility if the facility and related raw/treated water conveyance systems are operable.

Power Outage Appendix includes:

- Fuel Analysis TM
  - Backup fuel storage for critical facilities
  - Refueling requirements for backup power operations
  - Refueling requirements for recovery incorporating outage scenarios

In the case of a stand-alone regional power outage, water supply may be available and facilities may be undamaged. However, operations and water deliveries may be curtailed due to the limitations of backup power generators and fuel storage and availability. An analysis was developed to quantify reasonable power outage durations and associated reductions in operations as a result of relying on backup power and fuel capabilities. A "burn rate" analysis was performed to determine the frequency of fuel deliveries needed, assuming existing fuel storage.

3.1.5. Maintenance Outage

Impacts due to maintenance outages are captured by other hazard categories, and thus were not developed into an outage scenario

The District takes several major facilities out of service each year for maintenance. The District maintains a facility shutdown schedule that identifies when and for how long these facilities will be taken out of service for maintenance. The schedule identifies shutdowns that are required for both capital and maintenance projects. The *Planned*

Maintenance and Other Facility Outages (Maintenance TM) details the District's historical and planned outage schedules.

An evaluation of facility maintenance outages determined that potential facility impacts due to maintenance activities are covered by other more severe outage scenarios being evaluated, such as seismic events. Therefore, maintenance outages were not specifically evaluated in terms of discrete outage scenarios, and were not a main driver in analysis of system performance and goals. However, as strategies and projects were developed to increase District reliability, operational flexibilities and capabilities for performing maintenance were considered as part of evaluations.

Maintenance Appendix includes:

- Major critical facilities in the raw and treated water systems that significantly impact District operations and require significant planning and coordination
- Facilities where simultaneous outages would be most problematic
- Facilities that have not been taken out of service for maintenance

3.1.6. Selected Hazard Categories

The representative outage scenarios appropriate for evaluating performance of the District system, and identifying potential needs and improvements, were determined through preliminary evaluations of outage scenarios and discussions with District staff. The outage scenarios selected and analyzed with respect to system performance and goals are summarized in **Table 8**. Due to potentially severe impacts from earthquakes and increased reliance on groundwater sources as a result, the concern of an earthquake occurring during a major drought was deliberated. A probability analysis was performed and documented in the Earthquake Outage Appendix. It was determined that probabilistically, there is a low recurrence interval for a major seismic event occurring simultaneously with a major drought. Due to the low likelihood, a specific scenario for major earthquake combined with major drought was not considered.

Table 8. Selected Hazard Categories

Hazard Category	Outage Scenario	Scenario Description
Climate Change and Extreme Weather	Extreme Storm	This scenario analyzed impacts to District facilities due to extreme storm events
Earthquake	San Andreas M7.9 Earthquake 1	This scenario analyzed facility outages due to a San Andreas earthquake with damage focused on the District's west side treated water system
	San Andreas M7.9 Earthquake 2	This scenario analyzed facility outages due to a San Andreas earthquake with damage focused on the District's east side treated water system
	Calaveras M6.9 Earthquake	This scenario analyzed facility outages due to a Calaveras earthquake
Delta Outage	Short-term Delta Outage (6 months)	This scenario analyzed loss of all imported water to the District for 6 months due to Delta levee failure
	Long-term Delta Outage (24 Months)	This scenario analyzed loss of all imported water to the District for 24 months due to Delta levee failure
Regional Power Outage	Power Outage	This scenario analyzed loss of power at several District facilities

These selected outage scenarios were used to define specific facility impacts and evaluate District system performance, and to identify appropriate projects and operational strategies to increase District reliability for supplying and delivering water. The specific facilities impacted in each of these outage scenarios are further defined in Section 3.2 below.

3.2. Specific Facility Impacts

Detailed study was performed to attribute the selected hazard scenarios to specific District facility impacts. Research efforts included incorporating available information such as reliability data from the 2005 WIRP and also additional analyses (e.g., the DRMS report and Climate Change Vulnerability Assessment) to identify facilities most likely to fail. Discussions with District staff further refined these selections to develop the final facility outage scenarios. **Table 9** summarizes the assumed facility impacts presented as days of repair time, for each of the final selected outage scenarios. There are a number of facilities with vulnerabilities that will be addressed by upcoming improvement projects as part of the District's Capital Improvement Program (CIP). For the purposes of this study, it was assumed that these facilities will not fail, as indicated with "CIP" in the table. More details on the facility outages are included in Task 5 TM.

System schematics of the District's treated water system were produced in order to create a visual representation of the infrastructure outages caused by the extreme storm and earthquake scenarios. (Note: Delta outages do not damage the District's infrastructure and thus did not require schematics). These schematics can be found in the Task 5 TM.

Table 9. Facility Repair Time (Days) for the Final Selected Outage Scenarios

Facility	RW/ TW	Extreme Storm	San Andreas EQ #1	San Andreas EQ #2	Calaveras EQ	Delta Short-Term (6 months)	Delta Long-Term (24 months)	Regional Power Outage
Bay Delta	RW					6 months	24 months	
Pacheco PP	RW	14						14
Pacheco Conduit R1	RW				21			
Penitencia Force Main	RW	CIP	CIP	CIP	CIP			
Santa Clara Tunnel	RW	60						
Santa Clara Conduit	RW		21		21			
Anderson/Coyote Reservoir	RW	CIP	CIP	CIP	CIP			
Coyote PP	RW	60						14
Cross Valley Pipeline	RW		14	14	14			
Calero Reservoir	RW	CIP	CIP	CIP	CIP			
Almaden Pipeline	RW		14	14				
Vasona PP	RW	60						14
SBA	RW	60	30	30	30			
Central Pipeline	RW		14	14				
Rinconada WTP	WTP	14	CIP	CIP	3			14
Santa Teresa WTP	WTP	14						14
Penitencia WTP	WTP	60	60	60	60			14
Penitencia Delivery Main	TW	CIP	CIP	CIP	CIP			
West Pipeline 1	TW	14	14					
West Pipeline 2	TW	14	10					
West Pipeline 3	TW	14						
Snell Pipeline	TW			14				
East Pipeline 1	TW			10				
Milpitas Pipeline	TW			10				
District/SFPUC Intertie	TW	3	3	3	3			14
Campbell Well Field	RW							14

CIP – Indicates facility will be addressed in upcoming improvement project and is assumed to not fail for the purposes of this study.

3.3. Level of Service Goals

Task 6 TM includes:

- LOS benchmarking research
- Preliminary Retailer discussions on LOS and tolerable outages
- Additional Retailer demand evaluation
- Existing and proposed District LOS objectives

LOS objectives can be used to measure system performance and guide system improvement planning. For the purposes of the IRP, LOS objectives represent performance standards or targets for which the District's system may strive to reach under various outage scenarios. The Task 6 TM details the existing and proposed LOS objectives for the District's system in selected outage scenarios.

As a result of customer demand evaluations performed in Tasks 4 and 6, this project considered one minimum winter month (February) as representing basic service and the base demand target for treated water delivery after a major disaster event. Winter demands are a reasonable benchmark for the minimum service to provide the public in the aftermath of a major disaster. Winter demands generally do not include landscaping and other significant outdoor water use that are present during other seasons, and which may be considered extraneous during emergency situations. It represented an amount based on historical data that can be reasonably associated with day-to-day continuity of residential and business operations and needs.

Minimum LOS Target

This project considered one minimum winter month (February) as representing basic service and the base demand target for treated water delivery after a major disaster event

Recent drought conditions have also further validated the use of one minimum winter month as a valid basic service benchmark, as community outreach and conservation efforts have been successful in achieving cut-backs from typical usage patterns. In the aftermath of a major disaster, particular considerations should be given to ensuring consistent public messaging at the regional level in order to keep actual basic service demands within a reasonable range.

LOS objectives for managed recharge were also considered for this project. Recent drought conditions have resulted in loss of recharge to some areas and a better understanding of short-term impacts.

Based on LOS benchmarking research, meetings with retailers, and discussions with District staff, a range of LOS objectives were considered for potential District system performance targets under various outage scenarios. LOS objectives may vary by hazards and outage scenarios, with varying degrees of water delivery targets and restoration times. **Table 10** presents a high-level concept of LOS impacts for various levels of improvements and investments, and corresponding restoration capabilities. The purpose of this matrix is to present a general "menu" of investment levels and resulting system performance, ***in concept only***. Further evaluations performed in subsequent project tasks quantified District system capabilities, led to understanding of specific needs and deficiencies, and identified specific improvement projects, in order to further refine the appropriate investment level and corresponding LOS goal and performance level.

Table 10. Level of Service Goals

Improvements/ Investment	Restoration Capabilities			
	Earthquake	Extreme Storm	Delta Outage Short-Term	Delta Outage Long-Term
None • No action	Winter Demands @ 30-60 days	Winter Demands @ 20-30 days	20% Reduction for 6 months	20% Reduction for 24 months
Operations only (~$1M/yr) District Enhancements • Staffing considerations • Trainings/certifications • Emerg. response planning • Contingency procedures • Coordination roles/resp. • Comm./Outreach Retailer Enhancements • Utilize backup sources • Operational config. • Increase GW/SFPUC • Increase pumping ops • Activate interconnections	Winter Demands @ 30-45 days	Winter Demands @ 14-21 days	20% Reduction for 6 months	20% Reduction for 24 months
$10+ Million CIP • PL repair capabilities • Intertie improvements • Critical isolation valves • Strategic GW wells • Increase backup power • Additional pumps at Calero Reservoir	Winter Demands @ 14-30 days	Winter Demands @ 7-14 days	20% Reduction for 6 months	20% Reduction for 24 months
$100+ Million CIP • Replace critical PLs • Redundant/parallel PLs • Redundant GW source • West-side Intertie	Winter Demands @ 7-14 days	Winter Demands @ 1-7 days	20% Reduction for 6 months	20% Reduction for 24 months
$1+ Billion CIP • New PL alignments • New TW source • New RW source	Winter Demands @ 1 day	Winter Demands @ 1 day	20% Reduction for 6 months	20% Reduction for 24 months

3.4. Retailer Tolerable Outage Considerations

A tolerable outage for retailers was defined as the reasonable amount of time that a retailer could continue to supply basic winter demands in the absence of District treated water deliveries. Meetings with District retailers were held to understand tolerances, concerns, and objectives for withstanding outages and reduced treated water delivery and groundwater recharge in response to major disasters. The notes from these retailer meetings are available in the Task 6 TM. Due to seasonal variations, discussions differentiated between winter (low demand) conditions and summer (high demand) conditions. Tolerable outages for retailers are summarized in **Table 11.**

Task 6 TM includes:

- Tolerable Outages
- LOS Discussion
- LOS meeting notes with each retailer

Table 11: Retailer Tolerable Outage Durations

Retailer	District Treated Water		Managed Groundwater Recharge
	During Winter	During Summer	
Cal Water	14 days	Hours	Unknown
Gilroy	Groundwater only system		60+ days to months
Great Oaks	Groundwater only system		2 years
Milpitas	Indefinite	Indefinite	Unknown
Morgan Hill	Groundwater only system		60 days
Mountain View	30 days	30 days	Unknown
San Jose Muni	3-5 days	Hours	3+ months
San Jose Water Company*	Indefinite	14 days	Unknown
Santa Clara	Indefinite	Indefinite	9+ months
Sunnyvale	Indefinite	7 days	Unknown

*varies by turnout and zone

Generally, a 30-day outage period/restoration goal may be tolerable for most retailers given their back up water supplies. Exceptions include Cal Water and City of San Jose (San Jose Muni), whose outage tolerances may be of shorter duration. Without District treated water supply, Cal Water would have difficulty serving specific areas of their system, particularly in the Vallco turnout area in Cupertino where there is limited groundwater capability to provide backup supply. Cal Water also has some pipeline capacity limitations that make it difficult to move water from their other areas. They could reasonably withstand a restoration period of up to two weeks. For San Jose Muni, District treated water is the only normally-available supply to their Evergreen service area. Backup groundwater wells in that area have limited capacity and state-mandated operational restrictions. As a result, restoration periods of more than three to five days may be a hardship for San Jose Muni. Selection of recovery periods longer than these stated tolerable restoration times may prompt projects specific to these retailer areas.

With regard to managed groundwater recharge, Morgan Hill is most vulnerable to a loss of District managed recharge. Given this knowledge, it has historically been the practice of the District to prioritize recharge to areas which may benefit Morgan Hill groundwater supply over other areas which may be more tolerant to reductions or outages of recharge. Following a major disaster, the District will continue to prioritize these recharge deliveries as such.

Santa Clara Valley
Water District

Infrastructure Reliability Plan

Chapter 4
Baseline System Performance

AECOM

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4 BASELINE SYSTEM PERFORMANCE

The District's ability to deliver water in the event of an outage scenario was evaluated based on the facilities that are assumed to fail as discussed in the previous chapter. Modeling and analyses were used to determine the capability of the District to restore retailer demands partially or in full, and to determine the restoration time for recovery with its current baseline system. It should be noted that planned capital improvements as discussed in the previous chapter were also assumed to be in place. Additionally, projects recommended in the District's 2012 WSIMP were assumed to be in place in evaluation of the Delta outage scenarios. The analysis quantified how long it would take to restore service to the East and West treated water systems, and to restore critical managed recharge operations in the event of an outage scenario.

This chapter presents an overview of damaged facilities and potential repair sequences necessary to restore treated water service to retail customers. The availability of treated water for each retailer at multiple time-steps following an outage is summarized. Additionally, this chapter includes an analysis of areas likely to fall below preliminary performance goals and require improvement. More detail can be found in the Task 7 TM.

4.1. Outage Scenario Modeling

For each outage scenario, the District project team analyzed the failed infrastructure and made assumptions on the priority and duration of repair activities – in other words, which facilities would be repaired first, and how long it would take to make repairs and return to operational service.

The team utilized the pipeline network model to check for hydraulic or supply constraints with specific facilities out of service. The District employs the following three models to analyze its water supply and distribution system:

Water Resource Planning Model: The Water Evaluation and Planning System (WEAP) model simulates the total management of current and future water resources in Santa Clara County.
Groundwater Models: MODFLOW models are used to evaluate groundwater storage and groundwater levels under various operational and hydrologic conditions.
Water Distribution Networks: Innovyze's H2ONet model allows staff to determine system hydraulic and capacity constraints. The District has three separate hydraulic models for its raw water and treated water east and west supply systems.

Task 7 TM:

- Presents an overview of damaged facilities and potential repair sequences necessary to restore treated water service to retail customers
- Determines which retailers experience a loss of District treated water in each outage scenario
- Summarizes the availability of treated water for each retailer at multiple time-steps following an outage

The District project team modeled a variety of operating conditions for each outage scenario to check what level of demands they are able to supply (minimum or average demands) to the water treatment plants under different pumping conditions. Using the information on repair assumptions and constraints, the team was able to determine the duration of each outage scenario to water delivery capabilities. The baseline performance of the District system was evaluated and documented in the Task 7 TM.

The following sections describe which side of the treated water system (East and West) experience loss of District treated water in each outage scenario and summarize the availability of treated water at multiple time-steps following an outage. The analysis assumed that the entire east or west side of the District's treated water delivery system would be out for the same amount of time, and restored all at once.

Recovery of critical recharge to the groundwater system is also presented. Groundwater wells are the sole source of water supply for the City of Morgan Hill, the City of Gilroy, and Great Oaks Water Company. In the case of City of Morgan Hill, prioritizing managed recharge is required to maintain groundwater levels sufficient for pumping at their wells due to their location on a shallow part of the groundwater basin. The City of Gilroy and Great Oaks Water Company are more resilient to reductions of managed recharge, due to their geographic location on a more plentiful and reliable portion of the groundwater basin.

It is important to note that this analysis only indicates availability of District supplies; availability of other treated water sources (such as groundwater or SFPUC supply) are not displayed here. More information on the retailer outages and repair sequences can be found in the Task 7 TM and Task 9 TM.

Task 9 TM:

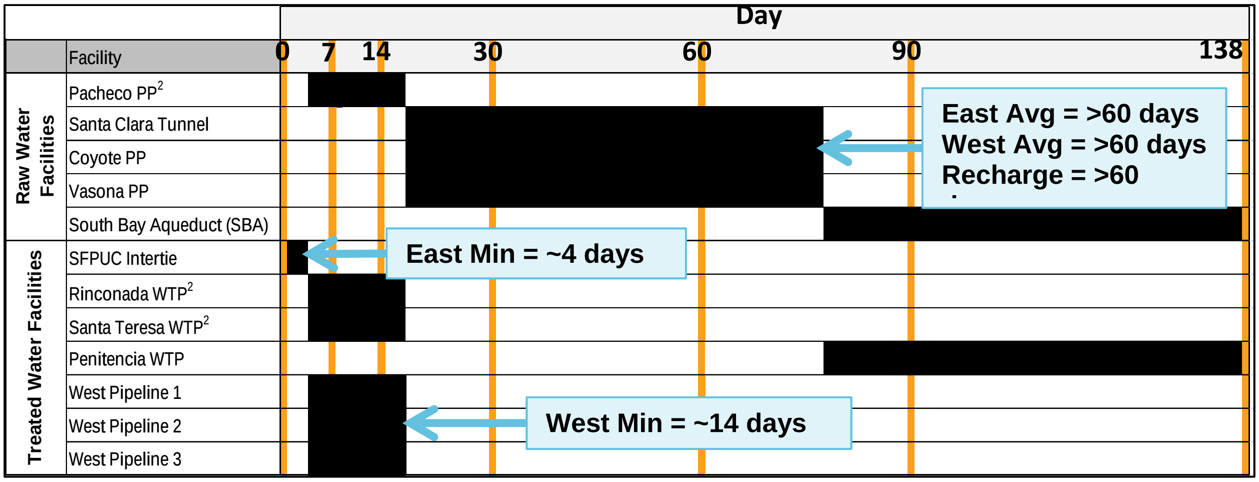
- Depicts availability of District supplies
- Provides visual representations of system delivery status for retailers throughout the recovery period

4.1.1. Extreme Storm

The District project team analyzed infrastructure outages caused by an extreme storm, and made assumptions on the priority and duration of repairs in order to determine the District's ability to restore service with its current baseline system, planned Capital improvements, and no additional improvements in place. The Extreme Storm scenario was expected to cause landslide damage to the Penitencia Water Treatment Plant and the SBA, which will likely take more than two months to repair. The H20Net model was used to confirm that the system does not have any hydraulic or supply constraints with some individual facilities out of service.

The Task 7 TM identified two repair sequences (Sequence A and B) to address the damage incurred from an extreme storm event. Both repair sequences prioritized repairing the West Pipeline first. The first repair sequence, Sequence A, then prioritized the restoration of San Felipe supplies. The second repair sequence, Sequence B, prioritized the restoration of SBA supplies. In this outage scenario, the restoration times for both repair sequences were the same. For brevity, only Sequence A is summarized in **Table 12**, for further details on both Sequences A and B, refer to Task 7 TM. The length of the black bars represent the duration for repairing each facility. At the time-steps when infrastructure would be repaired following an extreme storm, East and West-side retailers are able to receive increased amounts of District treated water.

Table 12. Extreme Storm Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.
[2] Failure Mode= Power

In this scenario, minimum demands could be restored relatively quickly, and with the wet weather conditions associated with an extreme storm, winter demands would likely be sufficient. The East-side retailers receive minimum demands after approximately four days, due to the availability of the SFPUC intertie. In the Extreme Storm scenario, the West pipeline is damaged, and service to the West-side retailers cannot be restored until it is repaired after approximately 14 days. Recovery of critical recharge in the storm scenario is over 60 days due to multiple landslide failures. It was assumed that in the extreme storm scenario, managed recharge would be less critical due to excess natural infiltration and runoff.

The District/SFPUC Intertie will require backup power to operate during the associated 14-day power outage, and assumed to require refueling every three days for continued operations. Following an Extreme Storm outage scenario, other critical facilities that require backup power, such as District pumping plants and water treatment plants, are expected to fail and already assumed to be non-operational during the associated 14-day power outage. Therefore, backup power is not needed for these facilities that are otherwise non-operational.

4.1.2. Earthquake

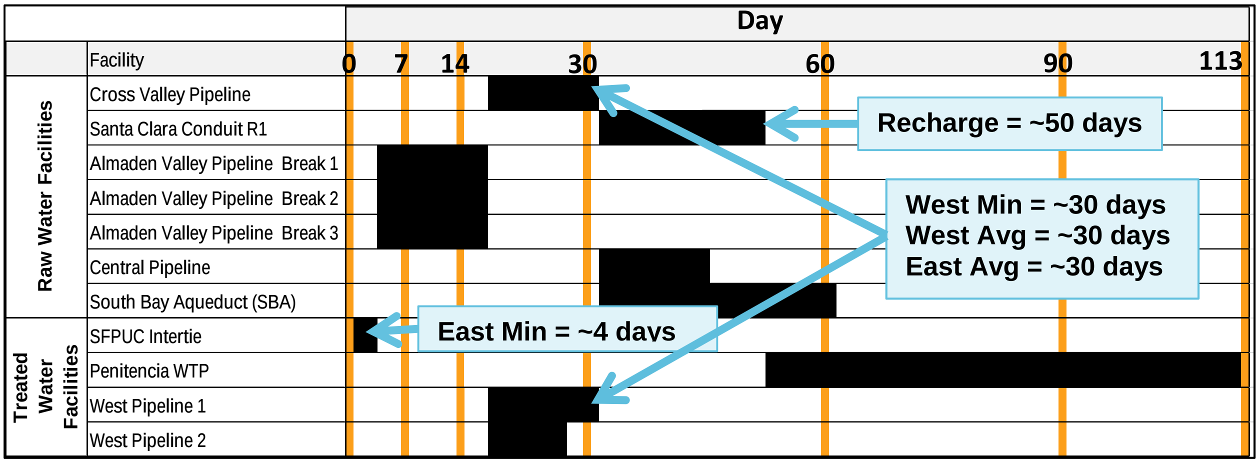
The District project team analyzed infrastructure outages caused by each earthquake scenario and made assumptions on the priority and duration of repairs in order to determine the District's ability to restore service with its current baseline system, planned Capital improvements, and no additional improvements in place. The H20Net model was used to confirm that the system does not have any hydraulic or supply constraints with some individual facilities out of service.

For each earthquake outage scenario, the Task 7 TM identified two repair sequences (Sequences A and B) to address the damage incurred from an earthquake event.

4.1.2.1. San Andreas Earthquake 1

The first repair sequence for a M7.9 San Andreas Earthquake 1, Sequence A, prioritized repairing the Almaden Valley and Cross Valley pipelines to restore local water supply sources (Calero and Anderson Reservoirs). The second repair sequence, Sequence B, prioritized repairing the SBA and Central Pipeline. Repair Sequence A resulted in superior system restoration. For brevity, only Sequence A is summarized in **Table 13**, for further details on both Sequences A and B, refer to Task 7 TM.

Table 13. San Andreas Earthquake 1 Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.

The East-side retailers would receive minimum demands from the District system after approximately four days once the SFPUC intertie is able to feed the East pipelines. After the breaks in West Pipeline 1 and 2 are restored, the West-side retailers would be able to meet average demands after approximately 30 days. The restoration of the Cross Valley pipeline after approximately 30 days restores average demands to the east retailers. Critical Recharge is restored after approximately 50 days upon restoration of the Santa Clara Conduit.

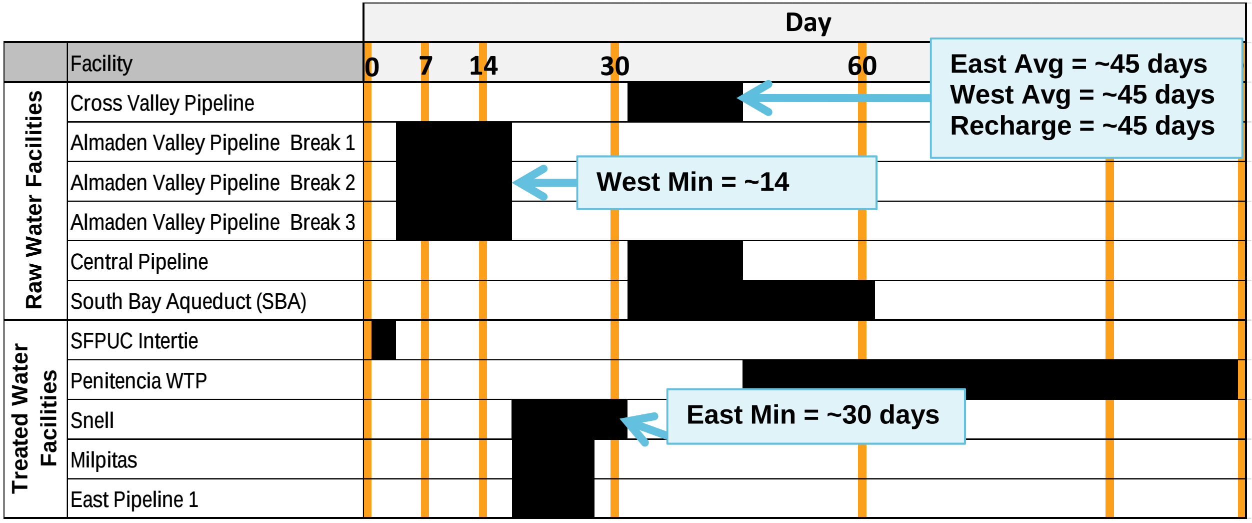
The District/SFPUC Intertie will require backup power to operate during the associated 14-day power outage, and assumed to require refueling every three days for continued operations. Following the San Andreas Earthquake 1 outage scenario, other critical facilities that require backup power, such as District pumping plants and water treatment plants, are either expected to fail or will receive no source water due to upstream facility failures, so are already assumed to be non-operational during the associated

14-day power outage. Therefore, backup power is not needed for these facilities that are otherwise non-operational.

4.1.2.2. San Andreas Earthquake 2

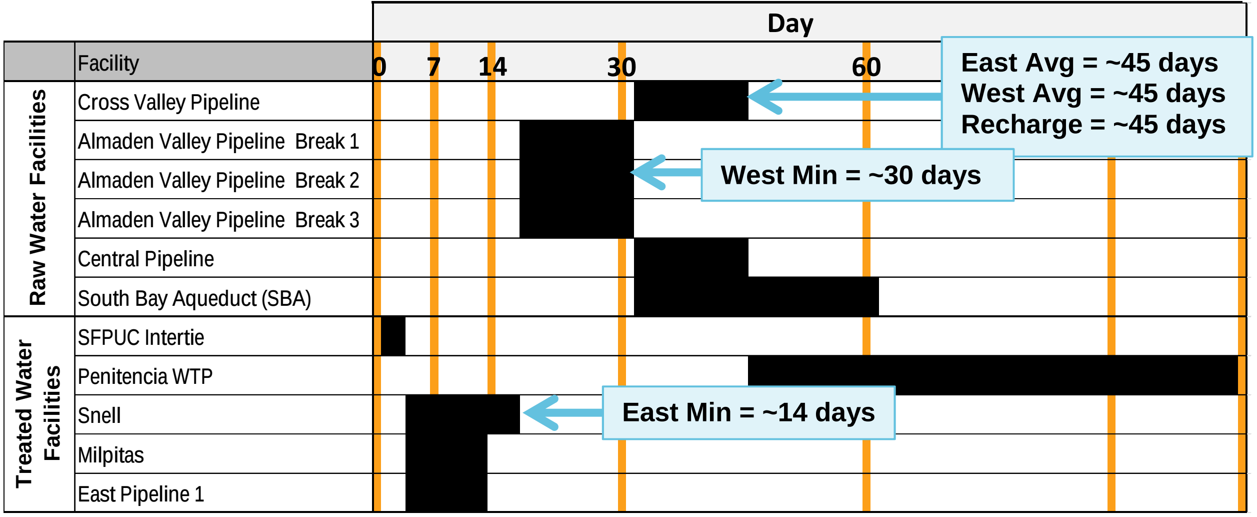
The first repair sequence for a M7.9 San Andreas Earthquake 2, Sequence A, prioritized repairing raw water pipelines to restore service to the West treated water system first. The second repair sequence, Sequence B, prioritized repairing the East treated water pipelines to restore service to the East treated water system first. Both scenarios are shown in **Table 14a** and **Table 14b**.

Table 14a. San Andreas Earthquake 2 Repair Sequence A[1]



[1] Sequence A shown here. See Task 7 TM for more details on both Sequences A and B.

Table 14b. San Andreas Earthquake 2 Repair Sequence B[1]



[1] Sequence B shown here. See Task 7 TM for more details on both Sequences A and B.

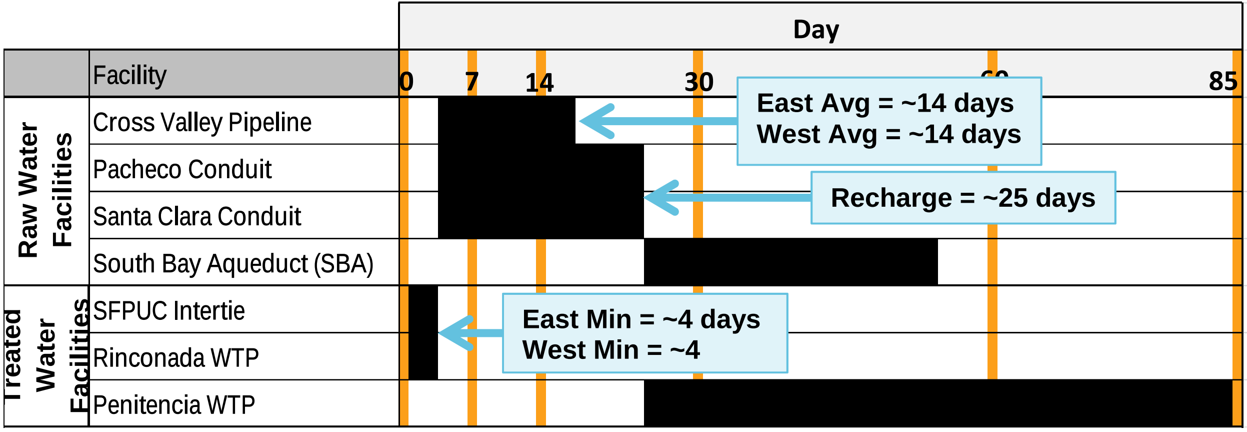
Since Sequence A prioritized West-side system repairs, the West-side retailers can meet minimum demands after approximately 14 days, while East-side retailers receive minimum demands after approximately 30 days. In Sequence B, East-side system repairs were prioritized, so the East-side retailers receive minimum demands after approximately 14 days, and West-side retailers receive minimum demands after approximately 14 days. Critical Recharge is restored after approximately 45 days in both scenarios.

After the San Andreas Earthquake 2 outage, most key facilities that require backup power (pumping plants and water treatment plants) are either expected to fail or will receive no source water due to upstream facility failures during the associated 14-day power outage, so it is assumed that backup power is not needed at those facilities. The District/SFPUC Intertie is expected to remain functional following the San Andreas 2 outage, but cannot be utilized while the Milpitas, East, and Snell Pipelines are out of service (a minimum of 14 days for repairs).

4.1.2.3. Calaveras Earthquake

The damages incurred from a M6.2 Calaveras earthquake are less significant and widespread when compared to facilities damages incurred from a M7.9 San Andreas Earthquake. Both repair sequences for a M6.9 Calaveras earthquake prioritized repairing the Cross Valley Pipeline first. The first repair sequence, Sequence A, then prioritized restoration of San Felipe supplies. The second repair sequence, Sequence B, prioritized the restoration of SBA supplies. Repair Sequence A resulted in superior system restoration. For brevity, only Sequence A is summarized in **Table 15**, for further details on both Sequences A and B, refer to Task 7 TM.

Table 15. Calaveras Earthquake Repair Sequence A[1]



[1] Scenario A shown here. See Task 7 TM for more details on both Sequences A and B

Both the East- and West-side retailers may receive minimum demands from the District system after approximately 4 days, and receive average demands after approximately 14 days. Critical Recharge is restored after approximately 25 days, once repairs to the Pacheco and Santa Clara Conduits are completed.

In the Calaveras earthquake scenario, fuel delivery to the following District facilities would be required during the associated and assumed 14-day power outage: SFPUC Intertie, Rinconada WTP and Santa Teresa WTP.

4.1.3. Delta Levee Failure

For both Delta outage scenarios (6-month and 24-month), it was assumed that all local District infrastructure will remain operational. It was assumed that an earthquake or flood event in the Delta is far enough away from Santa Clara County that it would not badly damage local infrastructure. The Delta outage evaluations looked to understand District capabilities for deliveries (treated water and groundwater recharge) in the absence of imported water and relying only on local storage. Analysis of the Delta outage scenarios in the Task 7 TM focused on whether or not the District could continue limited service for the outage duration with no imported water supplies. The WEAP and groundwater models were utilized to answer this question. The assumptions used to model the Delta outage scenarios are summarized on the left (*see textbox*).

Delta Outage Analysis:

- Utilized normal hydrology year (2002). A conscious decision was made to not combine major disasters (e.g., earthquake plus drought).
- Assumed the Governor would declare an emergency and call for 20% water use reduction. The reductions were phased over three months at a rate of 10%, 15%, 20% and then in place for remainder of outage scenario.
- Utilized 2025 water demand values from the 2010 Urban Water Management Plan
- Utilized the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) rule curves for the first six months of an outage.
- Assumed the SFPUC Intertie was available during summer months.
- Assumed the indirect potable reuse (IPR) and other WSIMP projects would be in place, with the exception of dry year options.

Analysis of 6-month and 24-month Delta outage scenarios showed that the District can continue service for both periods without any imported water supplies without causing any subsidence. The WEAP modeling results showed that there are unmet demands at the treatment plants and groundwater recharge facilities; however, the impacts of a Delta outage are largely operational as they would require retailers to supplement their supplies with groundwater via pumping and for District staff to actively manage the groundwater recharge program to meet any countywide needs.

Power outages that could impact District facilities are not expected during a Delta Levee Failure event.

4.1.4. Regional Power Outage

Fuel Analysis TM includes:
(Power Outage Appendix)

- Estimated daily fuel consumption rates by month for critical facilities

The regional power outage scenario analysis considered fuel requirements from a prolonged regional power outage with the assumption that all facilities are operable for the duration of the power outage (14 days) and will require emergency fuel storage and deliveries for continued operations. The goal of the analysis was to estimate how long the District can operate their system utilizing backup power. The analysis was limited to the District's water treatment facilities and the District/SFPUC Intertie. The District's pump stations were not specifically analyzed as they do not have generators large enough to run the pumps. The pump stations are not always required, as the District's system can operate by gravity when demands are low, which aligns with this project's LOS goal of minimum winter demands.

Existing on-site fuel storage for District facilities is limited to Rinconada WTP, Santa Teresa WTP, Penitencia WTP, and the District/SFPUC Intertie in the event of a prolonged regional power outage. Based on historic energy consumption and assumptions regarding future upgrades to Rinconada WTP, the District may be able to operate facilities on backup fuel storage for between 3 to 10 days, depending on the time of year and operating conditions. The District could operate on backup power for longer periods given regular external fuel deliveries. More details are included in the Fuel Analysis Memo.

4.2. Baseline District System Performance

After outage scenario modeling, the next step was to identify specific service areas and infrastructure that require reliability improvement projects due to a high probability of failure, large consequence of failure, or both. The purpose was to identify the shortfalls in the District's system performance with respect to the selected outage scenarios. This section identifies water system infrastructure and service area shortfalls that the District retail customers may experience in case of the selected outage scenarios.

Modeling showed that the District can continue service for both Delta outage periods without any imported water supplies without causing any subsidence, and that they are capable of preventing treated water outages to customers for a reasonable duration of time during a power outage. Therefore, the power outage scenario and the short- and long-term Delta outage scenarios are not included in the discussion on system shortfalls.

The total time that each facility will be out of service for the Extreme Storm, San Andreas 1, San Andreas 2, and Calaveras scenarios is provided in **Table 16**. These restoration times are based on assumptions regarding which facilities will fail in each scenario, assumed failure modes and repair times, suggested repair prioritization, and hydraulic model verification. The critical facilities are organized into groups that show their importance for meeting the LOS goals (minimum demands, average demands, and critical recharge). The impacts to the treated water system and to critical recharge are discussed in the following subsections.

Table 16. Total Number of Days to Repair Each Critical Facility During Outage Scenarios[1].

Facility	Raw or Treated Water Facility	Extreme Storm[2]	San Andreas EQ #1[2]	San Andreas EQ #2[3]	Calaveras EQ[2]
District/SFPUC Intertie	TW	4	4	4	4
Rinconada WTP	WTP	18			4
West Pipeline 1	TW	18	32		
West Pipeline 2	TW	18	28		
West Pipeline 3	TW	18			
Snell Pipeline	TW			18	
East Pipeline 1	TW			14	
Milpitas Pipeline	TW			14	
Almaden Pipeline	RW		18	32	
Days to Meet Minimum Demands	East	4	4	18	4
	West	18	32	32	4
Santa Teresa WTP	WTP	18			
Cross Valley Pipeline	RW		32	46	18
Coyote PP	RW	78			
Vasona PP	RW	78			
Days to Meet Average Demands	East	78	32	46	18
	West	78	32	46	18
Pacheco PP	RW	18			
Pacheco Conduit R1	RW				25
Santa Clara Tunnel	RW	78			
Santa Clara Conduit	RW		53		25
Days to Meet Critical Recharge Demands		78	53	46	25
Central Pipeline	RW		46	46	
SBA	RW	138	62	62	55
Penitencia WTP	WTP	138	113	106	85
Days to Return to Normal Operations		138	113	106	85

[1] Estimated outage durations are approximate and intended to be planning-level assumptions only, and do not indicate actual outage durations.

[2] Repair Sequence A represented

[3] Repair Sequence B represented

The expected time to restore minimum demands for each retailer for the Extreme Storm, San Andreas 1, San Andreas 2, and Calaveras scenarios are presented in **Table 17** below.

Table 17. Restoration Time for Minimum Demands to District Treated Water Retailers

Retailer		Extreme Storm	San Andreas EQ #1	San Andreas EQ #2	Calaveras EQ
East-Side Retailers	Milpitas	~4 days	~4 days	~14 to 30 days	~4 days
	San Jose Muni				
	SJWC East				
West-Side Retailers	Cal Water	~14 days	~30 days	~14 to 30 days	~4 days
	Mountain View				
	Santa Clara				
	Sunnyvale				
	SJWC West				

The analysis showed that District treated water service may be unavailable to retailers for approximately 4 to 30 days depending on the scenario. The results of Task 7 demonstrated that, in the worst case scenario, the expected outage and recovery time for the District to provide minimum demands to retailers is approximately 30 days. For less severe events, the expected outage time before minimum demands can be restored may be as little as approximately 4 days.

Tolerable outage durations are discussed and identified in **Chapter 3**. Many retailers could tolerate a loss of District treated water for at least one month during winter demand conditions, which was agreed upon as the target demand.

4.2.1. East Treated Water System Considerations

Due to availability of the District/SFPUC intertie, service can be restored to the East treated water system immediately, or within a few days in most scenarios. The intertie can supply approximately 40 MGD while minimum winter treated water demand for the East-side retailers is 42 MGD, resulting in only a 2 MGD deficit, which could be made up with conservation efforts.

With the exception of the San Andreas 2 Earthquake outage scenario, minimum demands can be restored within approximately 4 days without any system improvements. In the San Andreas 2 earthquake scenario, the East, Snell and Milpitas pipelines are damaged and minimum demands cannot be restored to the East retailers until those pipelines are repaired after approximately 14 days. Some level of investment would be required to ensure that East-side retailers can better tolerate potential outage durations of up to approximately 30 days in the San Andreas 2 outage scenario.

Average demands can be restored to the East treated water system after approximately 14 to 75 days following an outage. The Cross Valley Pipeline must be restored in order to restore average demands in all of the earthquake outage scenarios. In an Extreme Storm outage scenario, power to the Santa Teresa WTP is more quickly restored, but the Coyote and Vasona pumping plants take up to approximately 78 days to repair and restore average demand operations.

Most East side retailers can tolerate a loss of District treated water for at least one month during winter demand conditions, which was selected as the target demand. However, San Jose Muni noted that they could potentially only tolerate loss of District treated water for less than one week in winter depending on operating conditions.

4.2.2. West Treated Water System Considerations

The range of restoration times to provide minimum demands for the West system varied by scenario, from approximately 4 days to 30 days. In the Extreme Storm scenario, the West pipeline is damaged, and service cannot be restored until it is repaired after approximately 14 days. In the San Andreas 1 Earthquake scenario, the Almaden Valley Pipeline and West pipeline are expected to fail in multiple locations. Service cannot be restored to the West system until these two pipelines are repaired, which is estimated to occur at approximately 30 days. In the San Andreas 2 earthquake scenario, the Almaden Valley Pipeline is expected to fail in multiple locations, but the West Pipeline remains intact. As such, service can be restored once the Almaden Valley Pipeline is repaired, after approximately 14 days. The Calaveras earthquake scenario is the least severe of the four outage scenarios. It does not assume damage to the West or Almaden Valley Pipelines. As such, Calero supplies would be available for treatment at Rinconada WTP, and minimum demands can be met after approximately 4 days.

The same facilities needed to restore average demands to the East treated water system are also necessary to restore average demands to the West treated water system. Depending on the earthquake outage, the Cross Valley Pipeline takes between approximately 14 to 45 days to repair and restore average demand operations to the West. In an Extreme Storm outage scenario, the Santa Teresa WTP, and the Coyote and Vasona pumping plants must be repaired to restore average demands to the West.

Some level of investment would be required to ensure that West-side retailers can better tolerate potential outage durations of up to approximately 30 days in the San Andreas outage scenarios. Although most West side retailers can tolerate a loss of District treated water for at least one week during summer and at least one month during winter, Cal Water noted that they could potentially only tolerate loss of District treated water for several hours in summer and two weeks in winter depending on operating conditions.

4.2.3. Critical Recharge Considerations

Recovery of critical recharge in the earthquake scenarios ranges from approximately 25 to 50 days. In the San Andreas 2 scenario, critical recharge is restored upon completion of repairs to the Cross Valley pipeline after approximately 45 days because the Santa Clara Conduit is not damaged in this scenario. The Santa Clara Conduit needs to be repaired in order to restore critical recharge in the San Andreas 1 and Calaveras scenarios. Recovery in the extreme storm scenario is much longer, at approximately 75 days, due to failure of several pumping plants and multiple landslide failures.

In the Delta modeling efforts in Task 7, the project team found that all retailers can sustain groundwater pumping for up to 60 days with no managed recharge. It is assumed that in the Extreme Storm scenario, managed recharge would be less critical due to excess natural infiltration and runoff.

Improvement projects already in the District CIP will enhance supply reliability to Main and Madrone ponds in support of critical recharge.

Critical recharge may be restored more quickly than the numbers presented in **Table 16**. The District is currently improving the Main and Madrone pipelines, which will allow the District to deliver water from Anderson reservoir to the Main and Madrone ponds. Additionally, the District can supply the Main and Madrone ponds by backfilling the Santa Clara Conduit using Anderson supply to reach the raw water turnouts in Morgan Hill. The ability to do so depends on various operational considerations, and would be evaluated during an emergency for feasibility and need.

4.2.4. Pipeline Considerations

The pipeline damage analysis narrowed down specific areas of vulnerability for pipelines with high probabilities of failure due to seismic hazards, pipe age, and pipe material. Note that current pipe condition was not included in the probability of failure analysis. The analysis extended and updated the work performed in the previous 2005 WIRP. By utilizing this planning-level assessment, the District may be able to focus repairs and rehabilitations, and prioritize the critical sections of pipelines expected to fail.

Critical sections of each District pipeline were identified by delineating pipeline segments with the highest number of expected potential breaks or leaks. **Table 18** summarizes the percentage of length of these critical sections compared to the total lengths of the entire pipelines. The critical section data was combined with other relevant data and displayed in comprehensive seismic hazard maps. The pipe damage analysis maps visually demonstrate the potential for District facility failure in both the San Andreas and Calaveras earthquake outage scenarios.

Pipe Damage Analysis Maps (Earthquake Appendix):

- Used to identify and assess locations of critical pipeline sections in relation to known geologic hazards
- Planning-level information that may support development of prioritization for improvements
- See Task 9 TM for pipe damage analysis methodology

The critical section maps were reviewed by a seismic expert (Don Ballantyne) for insight on the locations of likely failure points. The pipelines that have critical sections that may be considered higher priority for the District to repair are noted in **Table 18**, along with information from the Risk Exposure Analysis and the results from the Pipeline Damage Assessment. It should be noted that this analysis was not conducted with the intent of meeting the LOS Goals with respect to the selected outage scenarios. A facility might have high vulnerability and/or high priority due to geologic and seismic hazards, but the repair may not necessarily lead to achieving the LOS goals set forth in this project. More information can be found in Task 9 TM.

Table 18. Summary of Pipeline Damage Assessment

Facility	Critical Section as Percentage of Total Pipeline Length	Repair Priority Recommendation by Seismic Expert
Almaden Pipeline	41%	High
Central Pipeline	36%	High
Cross Valley Pipeline	38%	Medium
East Pipeline 1	36%	Low
Milpitas Pipeline	43%	Low
Pacheco Conduit R1	21%	Medium
Santa Clara Conduit	51%	Medium
Snell Pipeline	55%	High
SBA	39%	Medium
West Pipeline 1	44%	Medium
West Pipeline 2	32%	Medium
West Pipeline 3	10%	Medium

4.3. Risk Exposure

It would be very expensive, and may not be feasible to undertake improvement projects for all the facilities expected to fail in the outage scenarios. The next steps take a closer look at the risk exposure of each facility in order to help prioritize improvement projects. The levels of risk that the District and regional partners are willing to accept will influence the selection of level of service goals and corresponding system improvements needed.

Risk exposure was analyzed for each District facility. The factors contributing to risk exposure include the probability of failure and the consequence of failure. The Task 9 TM details the process for developing risk exposure scores for District facilities. **Figure 8** provides a summary of the resulting risk exposure scores for District facilities that are impacted by any of the earthquake outage scenarios (5=Highest Risk, 1= Lowest Risk). The high risk facilities were used to help inform the project screening process which is discussed in **Chapter 5**.

Task 9 TM includes:

- Risk exposure methodology
- Risk exposure scores for critical facilities

Figure 8. Schematic of District's System with Color Coded Risk Exposure Scores

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4.4. Regional Response Capabilities

This section discusses strategies to improve system shortfalls following an outage scenario. The project team worked with internal and external stakeholders to assess existing regional capabilities and to identify potential new regional projects for meeting level of service goals. Regional area maps were developed to better understand the general geography of how facility outages may impact the District and retailers at a regional level.

Regional Area Scenario Maps (Task 8 TM):

- Illustrates outage scenarios in schematics
- Displays specific facility outages (red)
- Presents availabilities of customer turnouts correlating with failed or intact pipelines

4.4.1. Excess Capacity

Additional efforts for Task 8 led to further understanding of capacity, minimum usage, and available excess supply by retailer and water supply type. Combining this information led to a more comprehensive regional supply versus demand picture that shows where potential excess capacity from one water supply source may be adequate or helps compensate for shortages in other water supply sources. The recovery goal is to provide the total minimum water demands (169 MGD) from the available sources for each of the outage scenarios. **Table 19** identifies where excess system capacity may be available from each source for each retailer. The purpose of this information is to determine if there is potential available excess supply for meeting the LOS goals.

Task 8 TM includes:

- Maximum infrastructure transmission capacity of each water supply source for each District retailer
- Minimum retailer usage by source utilizes historical retailer demand data
- High-level regional and retailer-specific supply and demand picture

Table 19. Excess Capacity for Retailer Water Supply Sources (MGD)[1]

Retailer	Groundwater	District Treated Water	SFPUC	Local Surface Water	Total Excess Capacity
Cal Water	11.0	0.8	n/a	n/a	11.8
Gilroy	14.1	n/a	n/a	n/a	14.1
Great Oaks Water Company	23.8	n/a	n/a	n/a	23.8
Milpitas	1.7	10.6	30.8	n/a	43.1
Morgan Hill	11.5	n/a	n/a	n/a	11.5
Mountain View	6.0	1.9	5.1	n/a	13.0
San Jose Muni	16.4	21.2	18.3	n/a	55.9
SJWC	72.5	135.4	n/a	14.5	222.3
Santa Clara	43.4	2.4	8.2	n/a	54.0
Sunnyvale	8.3	12.5	46.9	n/a	67.7
SFPUC Intertie	n/a	n/a	40	n/a	40
TOTAL	208.7	184.8	149.2	14.5	557.2

[1] Excess capacity may not be accessible to all parts of Retailer systems, as there may be system and geographical constraints on utilizing alternative supplies.

From a regional perspective, there may be potential excess capacity of more than 200 MGD in groundwater, more than 140 MGD in SFPUC, and more than 10 MGD in local supplies which may be utilized to offset shortages in District treated water supply. However, retailer systems may not necessarily have capabilities to utilize this excess capacity in all portions of their systems to replace District treated water demands, and supply may not be available when needed. The retailers have multiple pressure zones or service areas for water distribution that may be served by one or more different water supply sources.

4.4.2. Back-Up Supply

The specific zones within retailer service areas where each supply source is utilized as the primary potable water source are identified in the Task 8 TM. Retailer back-up supplies were also evaluated in order to identify specific areas which have redundant supply capabilities in case the primary water supply sources are unavailable. The retailer service areas were evaluated and summarized in **Table 20** in order to identify the locations or zones within each retailer service area that rely on primary water sources, and whether there is capability to utilize back-up supplies in case of emergency outages. This effort represented the next step in understanding how the excess capacities may be effective and further improved if needed.

Task 8 TM includes:

- Specific zones within retailer service areas where each supply source is utilized as the primary potable water source
- Detailed tables that include information on backup sources for all retailers

This effort found that many retailer zones that are primarily served by District treated water have one or more backup supplies available, such as groundwater wells, interties, and SFPUC supply. For retailers that are groundwater supply only, Morgan Hill is more sensitive to groundwater shortages, while Gilroy and Great Oaks Water Company have more plentiful groundwater conditions. These efforts provided insight to identify specific retailer service areas that can and cannot access groundwater supply to replace loss of District treated water.

Table 20. Primary Source of Supply for Each Retailer Zone and Availability of Back-Up Supply Source[1]

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4.4.3. Groundwater Supply and Demand Analysis

There is potentially over 200 MGD of total excess groundwater supply capacity among the District-served areas, and there may be opportunities to utilize this supply redundancy, and/or enhance this capability where needed. A groundwater supply and demand analysis was developed in Task 8. The purpose was to understand the groundwater supply capacity in relation to District treated water turnouts. This provided a better understanding of the capabilities and limitations of using groundwater to supply both areas that typically rely on groundwater and areas that typically rely on District treated water. Existing groundwater well capacity was assumed to be sustained after the event.

Task 8 TM includes:

- Groundwater supply and demand analysis
- Retailer groundwater well capacity summary table

Table 21 combines the minimum demands used by each retailer from groundwater and District treated water and compares it to the maximum groundwater capacity. The objective of this exercise was to identify areas where groundwater capacity alone is or is not adequate to meet total minimum demands in the event of an outage of District treated water service.

Table 21. Excess Groundwater Supply per Retailer Service Area

Retailer	Primary District Treated Water Service Areas	GW Capacity	Minimum GW Usage	Minimum Treated Water Usage	Potential GW Shortage/Excess
Cal Water	Farndon	11	2.0	4.0	+5.8
	Granger				
	Covington				
	Vallco	2		1.2	
Milpitas	Zone 1SC	1.7	0	3.8	-2.1
	Zone 2 SC				
Mountain View	Zone 3	0	0	0.6	-0.6
Santa Clara	Zone 2A	2	0	3.4	-1.4
San Jose Muni	Evergreen	8.6	6.2		+2.4
SJWC	District Turnouts (11 Zones)	100	27.5	46.6	+25.9
Sunnyvale	Zone 2	9	0.65	6.1	+2.3
	Zone 3				

In some cases, groundwater capacity alone is greater than required minimum demands, and thus may have the ability to replace loss of District treated water. In other cases, groundwater capacity is inadequate to supplant District treated water service. The analysis helped to assess where (geographically) groundwater is available to offset loss of District treated water, and also where additional enhancements are needed.

Retailer Appendix includes:

- Groundwater Supply Overview Maps for each retailer
- IRP Retailer Supply Source and Service Area Maps
    - Developed for the IRP
    - Combines information from Groundwater Supply Analysis with Retailer Service Area Maps

4.4.4. Water Transfer Considerations

This section identifies additional water transfer opportunities between retailers in order to share potential excess groundwater capacity and help tolerate outages of District treated water service in emergency events. In some cases, it may be possible to transfer excess retailer groundwater through District treated water pipelines among adjacent retailers. Retailers that can potentially provide additional groundwater to District treated water pipelines are shown in **Table 22.**

There is currently good potential for inter-retailer transfers of excess groundwater capacity from Great Oaks and San Jose Water Company. With additional enhancements or improvements, Cal Water and San Jose Muni may also be in better position to achieve inter-service area or even inter-retailer transfer of excess groundwater.

Table 22. Potential Excess Groundwater Transfers

Retailer	Zone	Excess Groundwater Capacity	Potential to Transfer to Other Retailers?
Cal Water	All District Turnouts	5.8	Yes[1]
Gilroy	Zones 1-3	14.1	No
Great Oaks	9 Zones	23.8	Yes
Milpitas	N/A	N/A	No
Morgan Hill	23 Zones	0[2]	No
Mountain View	Zone 1-2	4.9	No
Santa Clara	Zone 1, 1A, and 2	41.4	No
San Jose Muni	Evergreen	2.4	Yes[3]
	Edenvale	3.8	No
SJWC	District Turnouts (11 Zones)	25.9	Yes
Sunnyvale	Zones 2-3	2.3	No

[1] If treated water service to Vallco turnout fails, inter-retailer transfer from Cal Water may not be possible, as there are only 2 existing wells in the Vallco turnout area, and transmission capacity within the distribution system is limited.

[2] Groundwater conditions are sensitive to recharge conditions

[3] Evergreen service area has a uni-directional intertie to Edenvale service area, however there are operational restrictions on the Evergreen groundwater wells.

4.5. Reliability Improvement Needs

By integrating information on the retailer service areas that are particularly vulnerable to outages of District services, and the outage scenarios which reflect the most vulnerable District infrastructure, a clear picture of the reliability improvement needs were identified. **Table 23** describes the specific vulnerabilities of these particular retailer service areas, and identifies the critical areas to target for improvement projects. This effort found that improvement projects that target specific service areas may efficiently address the existing reliability issues. The next chapter reviews the projects and strategies to address these system needs.

Table 23. Reliability Improvement Needs

Retailer	Area	Vulnerability
Cal Water	Vallco turnout area	Limited back-up near Vallco, difficult to move water from West Pipeline turnouts to Vallco turnout area.
Milpitas	Milpitas turnout area	Requires operational and valve changes, and is more costly to operate on SFPUC water.
Morgan Hill	All	Groundwater supply is sensitive to reduction of groundwater recharge.
Mountain View	Zone 3 (Miramonte)	Requires operational and valve changes, and additional pumping costs.
San Jose Muni	Evergreen area	Back-up groundwater wells in Evergreen are not permitted for regular use.
Santa Clara	Zone 2A (Serra Tank)	One 2 MGD well in Zone 2A, which has typical demands of 3-4+ MGD. Requires booster pumps from Zone 2.

Santa Clara Valley Water District

Infrastructure Reliability Plan

Chapter 5
Portfolio Recommendations

AECOM

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5 PORTFOLIO RECOMMENDATIONS

Task 11 TM:

- Presents the methodology and process of identifying and refining recommended project list
- Summarizes the project screening criteria and considerations
- Presents the cost estimating methodology and results
- Discusses potential implementation for the recommended projects

Based on results presented in the previous chapter, improvement projects that help address the District's system reliability needs were identified and evaluated. The project evaluation methodology was developed to refine a large list of potential improvement projects and opportunities into final portfolios of recommended projects. Three levels of screenings were conducted to determine which projects efficiently provide the greatest benefits to system reliability while also being cost-effective and feasible. Included in the analysis were two stages of cost estimates (generic and project-specific), which aided in the portfolio refinement process.

This chapter presents the results of project analysis, culminating in final portfolios of recommended projects. The projects recommended in this plan are incorporated by reference into the District's Local Hazard Mitigation Plan (LHMP). The methodology for identifying recommended projects and for estimating costs is also discussed throughout the chapter. Additional information regarding the project identification and screening process can be found in the Task 11 TM.

5.1. Project Identification and Screening Process

The process of identifying project opportunities and appropriate analysis methodologies incorporates important elements and information gathered throughout the project. Discussions with District management and retailers led to an understanding that high investment levels could result in system performance beyond what is needed, and may not be affordable. There was a consensus that this project should lead to more efficient and more targeted opportunities that would fit within a reasonable investment level, while providing sufficient system reliability and performance.

Potential opportunities were identified and discussed throughout the project, via meetings, workshops, and specific information gathering efforts. Important concepts that have been incorporated in the identification of project opportunities and reflected in the analysis methodology include:

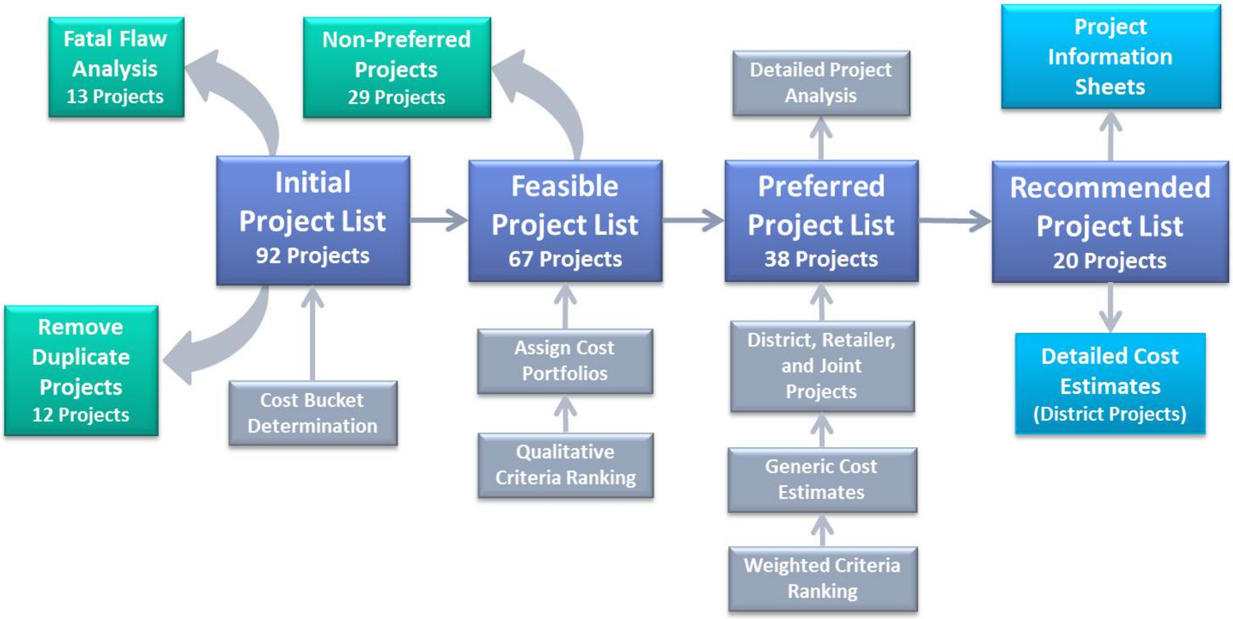
- Recent events impacting District services, such as planned and unplanned maintenance outages of District pipelines and treatment plants, and drought conditions, have led to more knowledge regarding alternate operational schemes.
- Many retailer service areas have sufficient backup supply redundancy and may not require large investments in additional reliability.

- There are specific retailer service areas that are more vulnerable to outages of District treated water. Reliability in these specific areas may be effectively improved with lower cost, localized solutions, rather than major infrastructure improvements.
- Strengthening the District's treated water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant raw water system damage. Likewise, the inverse applies as well, as strengthening the District's raw water pipeline system alone may not lead to dramatic reliability improvements for scenarios with significant treated water system damage
- Where possible and beneficial, leveraging existing assets is preferred, as both the District, retailers, and SFPUC have made significant investments in increasing system reliability and operational flexibility since the last 2005 WIRP study.
- Assets, particularly groundwater wells, which can be utilized more frequently to enhance daily operations or periodic maintenance operations, are preferred over assets that would be designated as standby for infrequent use only during major emergencies.

Project ideas were gathered based on input received from the District and retailers through several series of project meetings and workshops, and from regional master plans. The projects and opportunities were compiled into one initial project list of all potential opportunities, which contained 92 projects.

Project evaluation methodology was developed and a series of project assessment screenings was utilized to identify the recommended improvement projects. The goal was to identify the most feasible and beneficial projects that can effectively address the areas of need. This process is outlined in **Figure 9** and described in the subsequent sections. Additional documentation for all the interim project lists and analyses are provided in the Task 11 TM.

Figure 9. Overview of Project Screening Methodology



5.2. Initial Screening

The 92 potential projects were screened with an initial fatal flaw analysis to remove those that are not practical or feasible. This initial screening relied on qualitative data and engineering judgement by the project team, incorporating input from District staff, management and retailers. Considerations for classifying projects as impractical or unfeasible included recognizing projects with contractual hurdles or high costs and limited benefit. In this initial screening, 13 projects were eliminated and 12 were consolidated. A total of 67 feasible projects remained.

5.3. Secondary Screening

After the initial screening, the second round of evaluation gathered more details about the remaining 67 feasible project ideas. At this stage, additional information was collected and added to the project list. A high-level order-of-magnitude "cost bucket" was assigned to each project, as follows:

- $ = $1M range (operational improvements)
- $$ = $10M CIP range
- $$$ = $100M CIP range
- $$$$ = $1B CIP range

In general, stakeholders favored projects that would fit in an investment range of $10M to $100M. The projects in the $1B cost bucket were, for the most part, deemed too costly, and not realistic or achievable. The projects in the $1M cost bucket were viewed as minor quick fixes, or studies that would provide more information and/or increase preparedness in the event of an emergency.

The detailed rating criteria that were used to assess the feasible projects in order to identify preferred projects are described in **Table 24**. An expanded project scoring table can be found in Appendix 4 of the Task 11 TM.

Table 24. Project Rating Criteria

Rating Criteria	Description
Environmental	Projects score more points for providing specific environmental benefits. Examples of enhancements include: • Habitat restoration • Stream water quality improvement • Vegetation • Fish and wildlife support
Social/Community	Projects score more points for providing social or community benefits. Examples of enhancements include: • Reducing potential for property damage • Creating recreational opportunities
Supply/Capacity	Projects score more points for providing additional long term supply or capacity. Examples of enhancements include: • New sources of supply • Groundwater wells • Interties • Facility capacity upgrades
Operational Flexibility	Projects score more points for providing additional operational flexibility, particularly for withstanding facility shutdowns. Examples of enhancements include: • Provides supply redundancy • Facilitates wheeling or sharing water • Enables facility shutdowns
Ease of Implementation	Projects score more points for being more easily implemented. Characteristics considered include: • Land acquisition needs • Excavation requirements • Projects already in progress
Reliability	Projects score more points for increasing delivery reliability for retailers. Particular considerations are given to projects that: • Increase delivery reliability for retailers who currently cannot meet minimum demands in an outage scenario • Increase delivery reliability for retailers who currently cannot meet average demands in an outage scenario
Contribution to LOS	Projects score more points for potentially addressing one or more of the specifically identified vulnerable areas. Particular considerations are given to projects that: • Feed or wheel water through District pipelines to potentially reach vulnerable area(s) • Adds source/supply directly to vulnerable area(s)
Cost	Projects are estimated and grouped into cost categories to enable organizing into portfolios: • Operations only (less than $1 Million) • $1 to $10 Million CIP • $100 Million CIP

At this stage, the criteria were utilized to provide a qualitative analysis. Scores of “High”, “Medium”, and “Low” were designated and informed the screening process using engineering judgement. The feasible project list was narrowed down from 67 feasible projects to 38 preferred projects.

5.4. Final Screening

A final detailed analysis was conducted on the list of 38 preferred projects in order to develop recommended projects and opportunities, and to evaluate the portfolios against the preliminary level of service goals. Infrastructure sizes and locations, capital cost estimates, and benefits were refined in this step of the process.

5.4.1. Weighted Scores

In order to narrow down the list of preferred projects into a refined list of recommended projects, an overall weighted score was determined for each project. This quantitative analysis expanded upon the previous analysis by assigning numerical scores for each criterion, where “Low”, “Medium”, and “High” ratings correspond to scores of 1, 5, and 10, respectively. To calculate an overall score for each project, each of the seven criteria (excluding cost) was assigned a weight based on its relative importance. District feedback was used to finalize and weight the rating criteria. **Table 25** lists the weighting factor for each criterion and provides reasoning for the assigned weights.

Table 25. Criteria Weighting Factors

Rating Criteria	Weighting Factor	Explanation
Environmental	0.25	In an emergency, environmental concerns may be a lower priority. For example, permit violations may be preferable to serious and imminent risks to life safety.
Social/Community	0.25	In an emergency, social or community concerns may be a lower priority. For example, minor property damage may be preferable to serious and imminent risks to life safety.
Supply/Capacity	0.5	Identifies projects that provide multiple benefits, specifically enhancing the District’s long-term supply and capacity capabilities during normal operations, in addition to providing benefits during emergency events.
Operational Flexibility	0.5	Identifies projects that provide multiple benefits, specifically providing day-to-day operational benefits (such as for maintenance outages), in addition to providing benefits during emergency events.
Ease of Implementation	0.5	Accounts for the feasibility of construction, which is an important consideration for the recommended projects.
Reliability	1.0	Critical criterion that identifies projects that help restore minimum or average demands to retailers in the outage scenarios.
Contribution to LOS	1.0	Critical criterion that identifies projects that improve LOS for the specific vulnerable areas, and the District’s overall LOS.

Based on the weighting factors and individual scores of 1, 5, or 10, the highest total score that a project could receive is 40, while the lowest is 4. Recommended projects were selected based on a threshold total weighted score of **20 points** and above.

The project portfolios were further refined by analyzing the estimated costs of the projects. Total costs were roughly estimated for each preferred project based on generic assumptions and specifications.

Projects were also organized depending on which agency would lead the implementation. Projects on District facilities would be implemented by the District, while projects located within retailer service areas would generally be implemented by the respective retailers. In some cases, the project can be considered a joint project, meaning that the District and retailer would share the responsibility of implementation. Joint projects benefit both retailer and District systems and provide additional operational flexibility.

Initial Generic Cost Estimates (Task 11 TM):

- Preliminary generic assumptions and specifications (Appendix 4)
- Initial generic cost estimates and methodology (Appendix 5)

5.5. Recommended Portfolios

For the final recommended portfolios, 20 recommended projects were identified utilizing the weighted scores and initial cost estimates. **Table 26** includes the list of recommended projects along with the weighted scores and project-specific cost estimates for the recommended project portfolios. **Figure 10** shows the locations of the recommended projects, with labels corresponding to the project number in **Table 26**.

For the final 20 recommended projects, project information sheets were developed that include relevant details about the projects. In addition to a description of each project and its benefits, the project sheets include background information on the project area or retailer, the estimated project cost, and a project location map. Note that the Almaden Valley Pipeline project is not recommended for immediate implementation, but to be incorporated into the District's asset management program so that improvements are made at the same time the pipeline is rehabbed or replaced.

Project Information Sheets (Task 11 – Appendix 6):

- Description of projects and benefits
- Background information on project areas, including project location maps
- Estimated project costs

These recommended projects were presented and discussed at the Retailer Workshop held on June 1, 2016. Relevant comments from stakeholders were minor and have been incorporated. It is important to note that implementation of the projects included in the final recommended portfolios is dependent on other District and retailer priorities, ability to reach agreement on joint project arrangements, and other budget considerations.

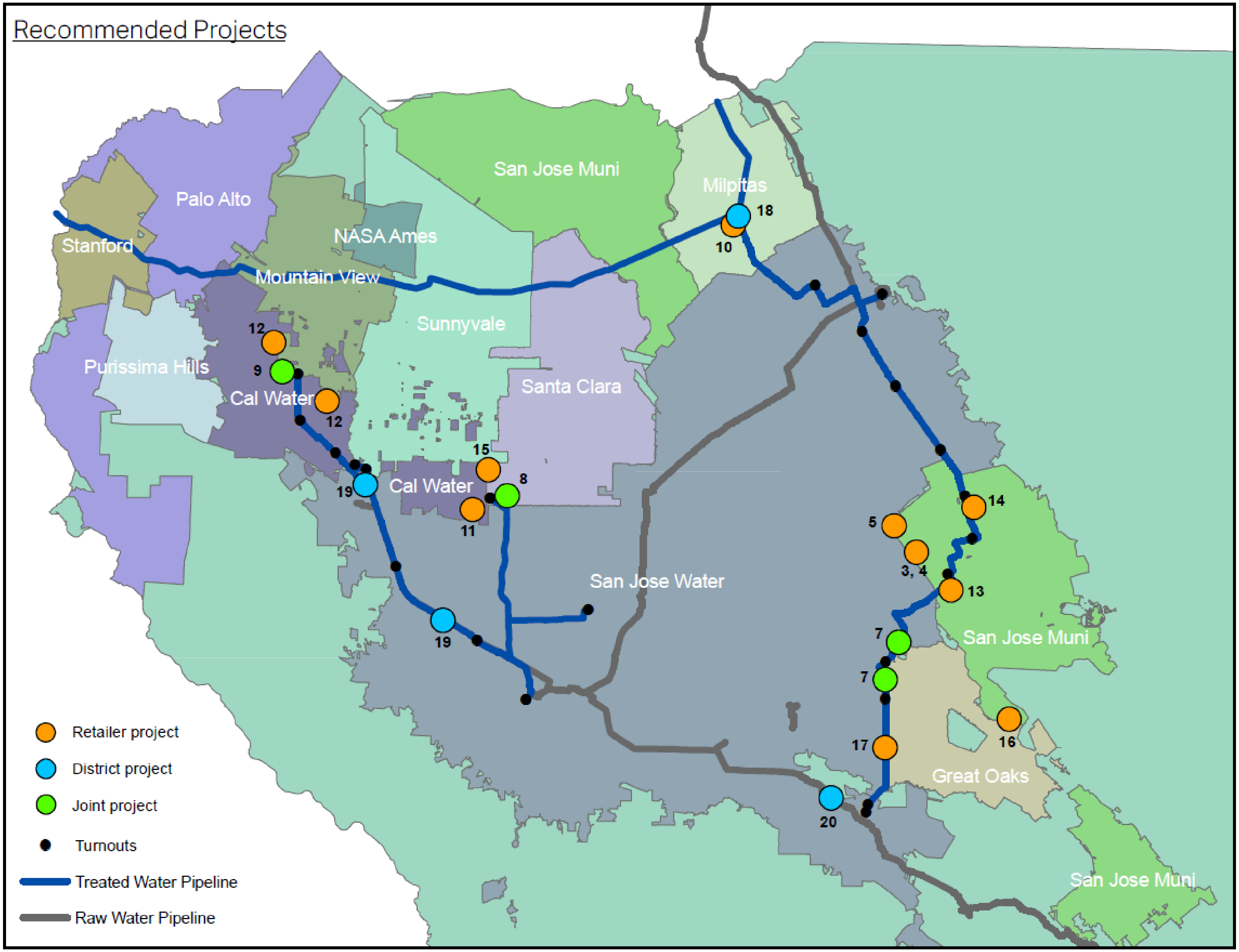
Table 26. Recommended Projects

Portfolio	Project #	Project Name	Weighted Score	Estimated District Project Cost	Estimated Retailer Project Cost[1]
Operations Only	1	Water Wheeling Study – Interagency use of District pipelines between customer turnouts	21	$0.5M	---
	2	Retailer Intertie Study – Test capabilities and capacities of interagency interties	21	District O&M budget	$0.5M
	3	Lift operational restrictions on San Jose Muni Evergreen groundwater wells	26	---	TBD
	4	Disinfection for San Jose Muni Evergreen groundwater wells	21	---	$1.0M
	5	Equipment to utilize existing interties between San Jose Muni Evergreen and SJWC	24	---	$0.5M
	6	Upgrade intertie between San Jose Muni Evergreen and Edenvale service areas	26	---	$0.2M
$10M CIP	7	New Great Oaks service connection on Snell Pipeline to feed excess groundwater	23	$1.1-1.4M[2]	TBD
	8	New groundwater well near Santa Clara Serra Tank in Zone 2A	36	$0.9M[3]	$2M[4]
	9	New groundwater well at Mountain View Miramonte Tank in Zone 3	36	$0.7M[3]	$2.8M[5]
	10	New groundwater well(s) at existing Milpitas site(s)	31	---	$2.8M[5]
	11	New groundwater well(s) at Cal Water Vallco turnout area	26	---	$2.8M[5]
	12	New groundwater well(s) at Existing Cal Water sites in western service area	21	---	$2.8M[5]
	13	New groundwater well(s) in Evergreen at new San Jose Muni sites	26	---	$2.8M[5]
	14	New groundwater well(s) near East Pipeline at new San Jose Muni sites	26	---	$2.8M[5]
	15	Develop additional and upgrade existing interties for Cal Water	21	---	$1.2M[6]
	16	New intertie between San Jose Muni Evergreen and Great Oaks	28	---	$1.2M[6]
	17	Upgrade two existing interties between Great Oaks and SJWC	23	---	$1.2M[6]
	18	Install two new isolation valves on Milpitas Pipeline	20	$1.4M	---
	19	Install three new isolation valves on West Pipeline	25	$2.2M	---
$100M CIP	20	Replace critical and vulnerable sections (~25,000 LF) of Almaden Valley Pipeline[7]	23	$135.3M	---

🟦	**District Project**
🟩	**Joint Project**
🟧	**Retailer Project**

[1] Retailer estimated costs are planning-level estimates only, based on preliminary discussion
[2] Estimated cost depends on location of connection
[3] For connection to District pipeline
[4] Santa Clara well at Serra Tank cost estimate provided by the City of Santa Clara
[5] Estimated price per well
[6] Estimated price per intertie
[7] Not recommended for immediate implementation. To be implemented as part of long term asset replacement projects.

Figure 10. Recommended Projects Map



Detailed Cost Estimates (Task 11 – Appendix 7):

- Includes project information packages used to develop detailed cost estimates.

The recommended project list contains 6 proposed projects in the Operations Only portfolio, 13 projects in the $10M CIP portfolio, and 1 project in the $100M CIP portfolio. Again, the one project in the $100M CIP portfolio would not be implemented immediately, but in the future as part of longer term asset management when the pipeline reaches end of life. Of these 20 projects, four would be implemented by the District and four would be implemented by the District and a retailer jointly. Detailed cost estimates were developed for the six projects in the $10M CIP and $100M CIP categories, and planning-level costs were estimated for the two studies in the operations category. The remaining projects would be implemented by individual retailers, so only planning-level costs are estimated and detailed cost estimates are not provided for these projects. It should be noted that it may not be necessary to implement all of the recommended retailer projects in order to achieve needed reliability benefits. It is up to respective retailers to determine which projects are most needed and would be most beneficial to pursue.

5.5.1. Project Descriptions

Operations Only Portfolio

Project #1 'Water Wheeling' Study: A study to assess the potential capabilities for wheeling water in District pipelines between customer turnouts could provide future benefits to the District and retailers. Specifically, it may be feasible for certain retailers with excess supply (such as SJWC and Great Oaks) to utilize District pipelines to feed water from one turnout to another in an emergency event that results in District service outages. This project is recommended due to its ease of implementation, low cost, and potentially significant enhancement to operational flexibility.

Project #2 Retailer Intertie Study: A study on the potential capabilities and capacities of retailer interties could provide valuable information on retailer systems and operations, particularly with regard to outage scenarios. Depending on the scenario, it could allow retailers with excess supply to directly feed other retailers who may experience a deficit. This should include feasibility study, as well as concepts for standardization of intertie design. This project is recommended due to its ease of implementation and potential benefits to multiple retailers within the District.

Project #3 San Jose Muni Evergreen Groundwater Well Restrictions: San Jose Muni cannot currently utilize all of their groundwater capacity due to State of California operational restrictions on groundwater wells in the Evergreen service area. The Evergreen service area was identified as particularly vulnerable to service outages, so lifting restrictions on the groundwater wells could provide an increase in system reliability and capacity.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #4 San Jose Muni Evergreen Groundwater Well Disinfection: San Jose Muni cannot currently utilize all of their groundwater capacity due to State of California operational restrictions on groundwater wells in the Evergreen service area. The Evergreen service area was identified as particularly vulnerable to service outages; it was the project team's understanding that adding disinfection capabilities to the groundwater wells could help ease these operational restrictions and provide increased system reliability.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #5 San Jose Muni Evergreen and SJWC Interties: New equipment, including pumps and hose or pipeline, to utilize three existing interties between San Jose Muni Evergreen service area and San Jose Water Company could enhance the resilience of the Evergreen service area at a relatively low cost.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

Project #6 San Jose Muni Evergreen and Edenvale Interties: Upgrades, including a new pump, to the existing intertie between San Jose Muni Evergreen and Edenvale service areas could allow bi-directional operations, which would provide improvements in operational flexibility and could enhance the resilience of the Evergreen service area at a relatively low cost.

It should be noted that it may not be necessary to implement all of the recommended San Jose Muni retailer projects in order to achieve needed reliability benefits. It is up to San Jose Muni which projects are most needed and would be most beneficial to pursue.

$10M CIP Portfolio

Project #7 Great Oaks Service Connection on Snell Pipeline: A new service connection from the Great Oaks system to the District's Snell Pipeline could take advantage of Great Oaks' excess groundwater capacity, estimated at up to 20 MGD depending on conditions. This project is recommended due to its reasonable cost and feasibility, and substantial increase in supply and operational flexibility for the District. There are currently two identified potential locations for the connection, located at Branham Lane or Valley Christian School.

Project #8 Santa Clara Groundwater Well: Santa Clara Zone 2A was identified as a vulnerable area with limited back up supplies. The construction of a groundwater well in Santa Clara Zone 2A near Serra Tank would increase system reliability and capacity for Santa Clara. Additionally, the well could tie into the Santa Clara Distributary near Serra Tank, improving the operational flexibility of the District's west treated water system. It is the understanding of the project team that implementation of this project is currently in progress by Santa Clara.

Project #9 Mountain View Groundwater Well: Mountain View Zone 3 was identified as a vulnerable area due to operational changes and additional pumping required to offset loss of District treated water. A new groundwater well in Mountain View Zone 3 near Miramonte Tank would increase system reliability and capacity for Mountain View. Additionally, the well could tie into the Mountain View Distributary near Miramonte Tank, improving the operational flexibility of the District's west treated water system.

Project #10 Milpitas Groundwater Well: Milpitas turnout area was identified as a vulnerable area due to operational changes and additional costs to offset loss of District treated water. A new groundwater well in Milpitas' District Zone would increase system reliability and capacity for Milpitas. Several potential sites have been identified, including Curtis Well site which has already been partially constructed, and sites located at McCandless Drive Park and former Montague Well site.

Project #11 Cal Water Groundwater Well at Vallco: Cal Water Vallco turnout area was identified as a vulnerable area due to limited availability of backup supplies to offset loss of District treated water. A new groundwater well in the Cal Water Vallco turnout area would increase system reliability and capacity for Cal Water.

Project #12 Cal Water Groundwater Well in West: Cal Water has existing sites in the western service area, including Stations #2 and #4, which have been identified as good opportunities for adding new groundwater well capacity. Additional groundwater well capacity in strategic locations would increase system reliability and capacity for Cal Water, to offset losses of West Pipeline turnouts, and also to increase the capability to move water east to the Vallco turnout area.

Project #13 San Jose Muni Evergreen Groundwater Wells: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New groundwater wells within Evergreen service area would increase system reliability and capacity for San Jose Muni by directly feeding the vulnerable Evergreen service areas.

Project #14 San Jose Muni East Pipeline Groundwater Wells: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New groundwater wells near the East Pipeline would increase system reliability and capacity for San Jose Muni by providing water near the existing District turnouts that serve the vulnerable Evergreen service areas.

Project #15 Cal Water Interties: Cal Water Vallco turnout area was identified as a vulnerable area due to limited availability of backup supplies to offset loss of District treated water. Developing additional and/or enhancing existing interties with neighboring service areas could increase system reliability and capacity for Cal Water. In particular, increasing intertie capability between Cal Water and Santa Clara could help address shortfalls near the vulnerable Vallco turnout area, and also provide operational flexibility for both retailers.

Project #16 San Jose Muni Evergreen and Great Oaks Intertie: San Jose Muni Evergreen service area was identified as a vulnerable area due to operational restrictions on backup groundwater wells. New intertie capabilities between Evergreen service area and the Great Oaks system would increase system reliability and capacity for San Jose Muni by utilizing potential excess groundwater capacity from Great Oaks.

Project #17 SJWC and Great Oaks Interties: As the largest District retailer, SJWC spans the largest service area and has the most service connections along District treated water pipelines. As a result, SJWC may have significant impacts on the overall regional capability for wheeling water through District pipelines between retailer service connections in case of District service outages. There are currently two existing interties between SJWC and Great Oaks. Upgrades to these interties, or possibly new interties with Great Oaks, could help utilize potential excess groundwater capacity from Great Oaks and enhance operational flexibility for SJWC.

Project #18 Isolation Valves on Milpitas Pipeline: Two additional isolation valves on the Milpitas Pipeline, one on each side of the existing Milpitas turnout, could improve reliability and operational flexibility in the District's east treated water system by allowing the District to valve off potential pipeline breaks more efficiently. This may also increase operational flexibility for utilizing the District/SFPUC Intertie.

Project #19 Isolation Valves on West Pipeline: Three additional isolation valves on the West Pipeline at strategic locations could improve reliability and operational flexibility in the District's west treated water system. These valves could allow the District to valve off potential pipeline breaks more efficiently, and continue to serve as many West Pipeline service connections as possible. This may also increase operational flexibility for wheeling water on District pipelines between retailers. Proposed locations include one on each side of the existing SJWC Cox turnout, and one upstream of the existing SJWC Mann turnout.

$100M CIP Portfolio

Project #20 Almaden Valley Pipeline Improvements: The Almaden Valley Pipeline is the most critical District facility expected to fail in the assumed outage scenarios. Through pipeline damage determinations, particularly vulnerable and high-risk sections were identified which total approximately 25,000 linear feet. It is recommended that the District consider the IRP evaluations specific to this issue in considering prioritization in its long-term asset management program.

5.6. Additional Recommendations

Throughout the process of the IRP project, the project team and District staff identified additional recommendations to continuously improve the resilience and recovery capabilities of the District system. The recommendations are not specific projects, and can be included in existing District programs:

- Continue to plan for recharge operations in critical areas during drought or other outages. In particular, upcoming improvements to Main and Madrone pipelines will support quicker restoration of critical recharge to the raw water turnouts in Morgan Hill.
- Continue Emergency Response Planning
    - Develop post-earthquake inspection procedures for pipelines
    - Develop emergency response plans for each pipeline, and for other facilities that do not have up to date plans
    - Renew standing orders for equipment and contractors that have expired
    - Secure retainer agreements for equipment and contractors if feasible
    - Continue to look for mutual aid opportunities, and continue participation in California Water/Wastewater Agency Response Network (CALWARN)
- Continue planned pipeline inspection and rehabilitation projects to identify sections in need of replacement
- Address seismic and climate vulnerabilities through long-term asset replacements
    - Replace vulnerable pipe segments with earthquake resistant design
    - Consider future climate conditions (extreme heat, stronger storms, etc.) in routine equipment replacements
- Consider adopting standard practice of installing isolation valves immediately upstream and downstream of each customer service connections
- Continue coordination with District groundwater subcommittee to ensure appropriate long-term practices with respect to additional groundwater wells and proper management of the groundwater basin
- Develop or enhance communications plans for conveying the message of conserving water after an earthquake or hazard event to Santa Clara County residents

5.7. Implementation Plan

The implementation of the recommended project portfolios will depend on several factors, such as District and retailer priorities and budget allocations. This section includes a preliminary high-level implementation plan for District and joint projects, with considerations towards achieving benefits efficiently. Prioritization is not based on criteria scoring from the previous project screening process, as other factors for implementation become relevant. Other considerations include the geographic location, interdependencies, and construction feasibility of recommended projects.

Table 27 organizes the recommended District and joint projects into implementation phases. Projects are aligned into East-side and West-side, as there should be strong considerations for grouping projects with interdependencies that can provide enhanced benefits if they are implemented concurrently.

Responsibility for implementation of the remaining retailer projects would fall under each project's respective retailer. The prioritization of the retailer projects should be determined by each retailer. It should be noted that several retailer projects may provide similar benefits, so further evaluation should be conducted by the retailers to determine which projects are most feasible and cost-effective.

Table 27. Project Implementation Considerations

Area	Project	Rank	Discussion
West	West Pipeline isolation valves	1	No-regret improvement, construction only on District facility, easy to implement, no additional agreements required
	Santa Clara groundwater well	2	Construction on retailer and District facilities, planning/coordination required
	Mountain View groundwater well	2	Construction on retailer and District facilities, planning/coordination required
East	Milpitas Pipeline isolation valves	1	No-regret improvement, construction only on District facility, easy to implement, no additional agreements required
	Great Oaks connection/turnout	2	Construction on retailer and District facilities, planning/coordination required
System/ Other	Wheeling water study	1	Planning study only, no construction and no agreements needed to initiate study
	Retailer intertie study	1	Planning study only, no construction and no agreements needed to initiate study
	Almaden Valley Pipeline improvements	3	High cost and complex construction, long-term improvement project

The projects assigned a rank of 1 (shaded in green) are the highest priority and most easily initiated, and can be implemented relatively quickly. The projects assigned a rank of 2 (shaded in orange) are achievable within a reasonable timeframe but may require additional coordination efforts and formal agreements between the District and respective retailers. The project assigned a rank of 3 (shaded in magenta) is the major infrastructure project for Almaden Valley Pipeline. This project is the most difficult to implement due to its high cost as a major infrastructure project, and will be considered in the District's long-term asset management planning.

5.8. Conclusion

The District water utility system faces a variety of hazard conditions, which could lead to outages of treated water service and critical recharge. This study evaluated District system performance in several selected outage scenarios. Based on results of the analyses, the District currently meets a LOS for providing treated water at minimum demands within approximately 30 days or less, and critical recharge within approximately 75 days or less[1]. Utilizing information gathered via stakeholder meetings and workshops, this study also evaluated system capabilities with respect to regional redundancies and backup supplies. The study found that most areas of the county have sufficient backup supplies or redundancy to withstand a District service outage; however, specific service area vulnerabilities were identified. These can be more efficiently addressed by smaller localized projects, rather than major system infrastructure improvements. Project opportunities to enhance reliability for these service areas and the system overall were developed and screened. Stakeholders agreed on an investment level with corresponding recommended projects that would allow retailers to better tolerate these District service outages. These projects may also reduce the District service outage durations, thus improving the District's LOS. This study endorses implementation of these recommendations in the interest of enhancing District and retailer system reliabilities and life safety for their customers.

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[1] *Note these are modeled outage durations based on modeling assumptions. In actual hazard events, outages may be longer or shorter depending on actual facility damage.*